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The Architecture of Rural Healthcare: Supporting access to health in remote and rural areas

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The Architecture of Rural Healthcare: Supporting access to health in remote and rural areas.

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Figure 1: RURAL (Martel)

ABSTRACT

Many remote and rural areas in the United States lack adequate access to basic healthcare services such as primary, urgent, and emergency care typically provided by healthcare systems and hospitals. In addition, many rural communities are comprised of an increasingly aging population, a growing number of patients with chronic illnesses, and in some communities a high volume of tourists that need urgent care. Remote communities struggle with providing access to these basic but essential healthcare services taken for granted in more populated areas. Changing reimbursement, evolving patterns of care delivery and advances in technology are all altering how access to medical care can be delivered in geographically isolated locations. At the same time, increasing healthcare provider shortages place a particular strain on access to medical care in rural communities. This evolving context for care in rural America increases the pressures to provide greater access to better care with limited physical and human resources. As a result, an even greater need exists today for rural healthcare providers to deliver care in an appropriately designed environment that can enable the highest possible level of care that is delivered more effectively with limited resources over time.

This thesis investigation identifies best practices on how to design of rural and remote community healthcare facilities that supports high quality and sustainable healthcare services. Healthcare settings in remote areas must support standardized care delivery by providers who may be remote or rotating between multiple communities while enhancing access to the highest level of care possible. Also, they must be sustainable and relatively self-sufficient front-line outposts that are physically distant from major medical resources.

A comprehensive literature and case study review was employed to identify background issues in healthcare and best practices for rural health care architecture. Databases searched include Academic Search Complete, Academic Search Premier, Alt Health Watch, Avery Index to Architectural Periodicals, CINAHL Plus with text, Health source, and Medline. From the literature review, over 83 articles were reviewed with 70 of these articles directly or indirectly applicable to topics related to rural healthcare objectives. Primary research was gathered through site visits and formal observations of selected best practice case studies in a cross section of rural and remote communities in the US and Canada along with interviews of design professionals and health providers associated with the identified projects.

The literature and case study research along with site visits was used to identify and develop a series of architectural design guidelines for rural medical facilities and a prototype program. The design guidelines generated include optimizing user accessibility, operating off the grid, constructing modular units, standardizing clinical spaces, creating adaptable spaces, and maximizing staff connectivity.

Key words: rural, United States, frontier, emergency care, primary care, clinic, and healthcare facilities and construction

Remote and rural communities are challenged with providing adequate and accessible healthcare. They face an increasingly aging population, a growing number of patients with chronic illnesses, and in many communities a high volume of tourists that need urgent care.

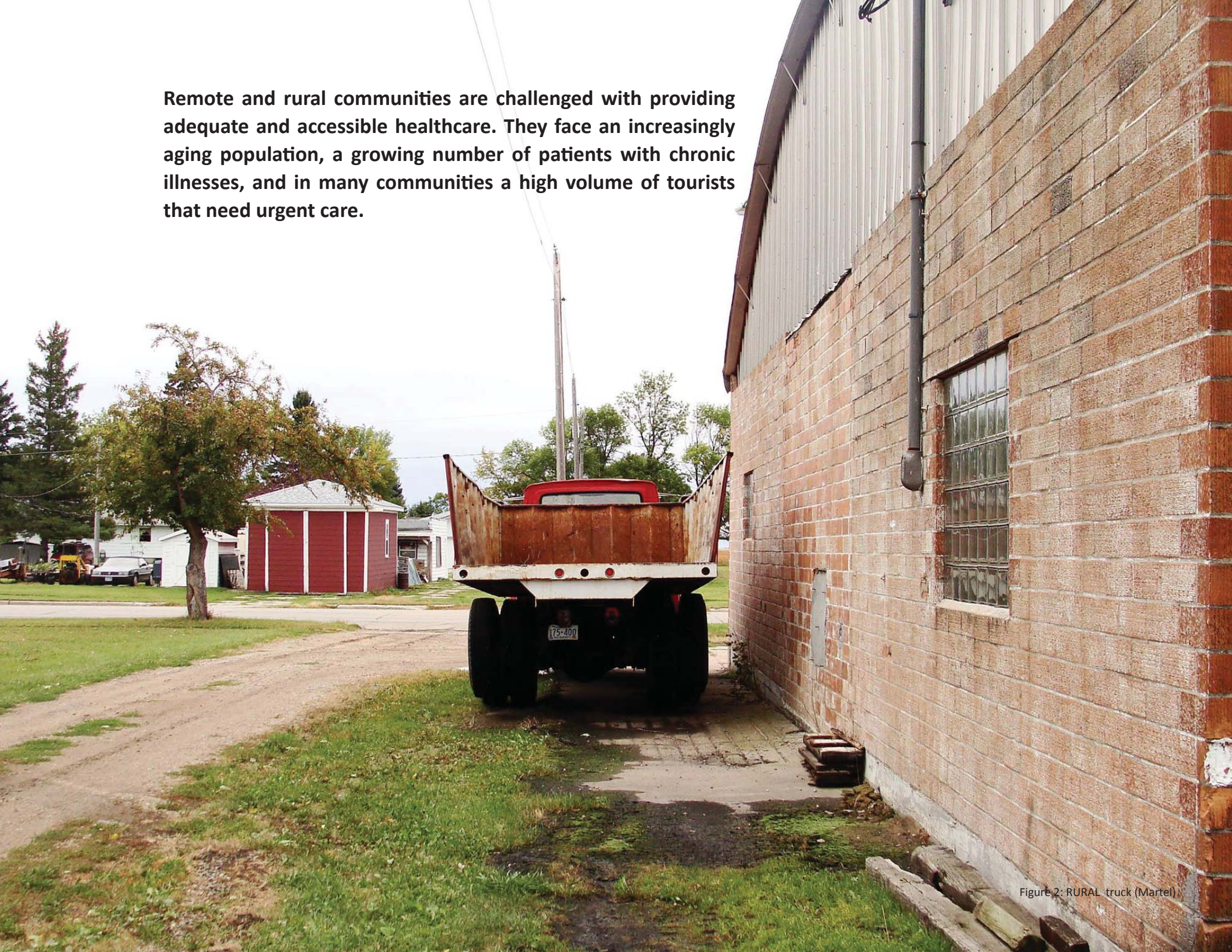

Figure 2: RURAL truck (Martel)

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FIGURES

CONTENTS

“The isolation and distances that classify an area as frontier result in long trips to attend school, shop for groceries, get healthcare, and reach other basic services.”

- Rural Assistance Center

Figure 3: RURAL landscape (Martel)

INTRODUCTION

This study of rural health explored existing research and precedents. The combined research focused on promoting access and delivery of healthcare to rural populations while supporting sustainable operations for medical facilities. Minimizing the distance between facilities and providing quality care at each clinic can make healthcare more accessible and relevant for people living in frontier regions. This thesis study investigated settings for the delivery of rural healthcare and best architectural practices on how the design of critical access healthcare environments can support sustainable healthcare delivery services in remote areas. What are the best practices in the design of frontier clinics that adequately support access to and the delivery of healthcare in remote and rural communities? This thesis identified best practices and developed a series of design guidelines that create and support accessible and adaptable healthcare settings. The healthcare context must include efficient and effective delivery of the highest quality care possible in rural locations. Rural areas struggle to access healthcare because of their geographical isolation and distance to healthcare facilities.

Background and Context

Rural communities are by their very location isolated from many basic services such as healthcare. A frontier lifestyle typically involves independent living and reliance on the natural environment. When accessible, healthcare services in frontier regions are typically used for primary care needs and urgent/ emergency care.

Definition of rural frontier: The classification of rural for this thesis measures frontier areas based on geographical distance, population density and travel time to hospitals. Qualifications for defining rural frontier came from the National Center of Frontier Communities (NCFC) and considerations from the National Rural Health Association (NRHA, 2008, Hart, 2012, p. 6 and Isserman, 2005, p. 466). Rural healthcare programs target the main frontier states – Iowa, Minnesota, Montana, Nebraska, North Dakota, South Dakota, and Wyoming (Stingley, 2014, p. 337). Alaska is also considered one of the target states as their low population requires additional services.

Geographical distance in the most remote frontier wilderness is defined by at least a seventy-five mile distance by road from the nearest hospital or it is inaccessible by public road. Forty-seven percent of the land mass in the United States is considered frontier (NCFC, 2012).

A population criterion for frontier is determined by county population density per square mile in the United States. Frontier county populations are defined by a density of six or less people per square mile. These populations are the most remote and geographically isolated areas in the country. Roughly 5.6 million people live in frontier areas. This is 1.8% of the United States population living on 47% of the

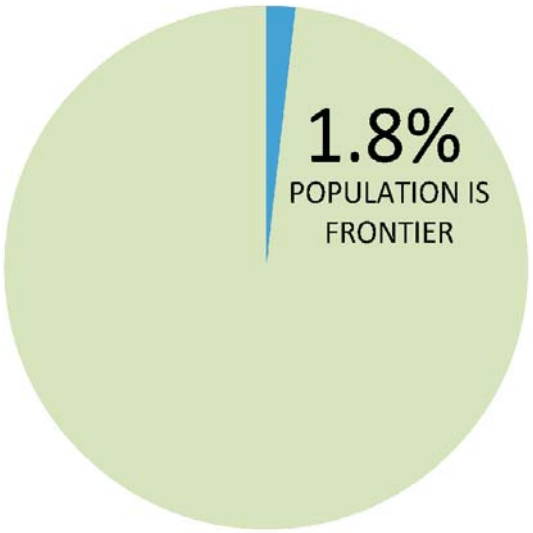


Figure 4: Population Percentage of Frontier People (Source: NCFC, 2012, Created by Staloch)

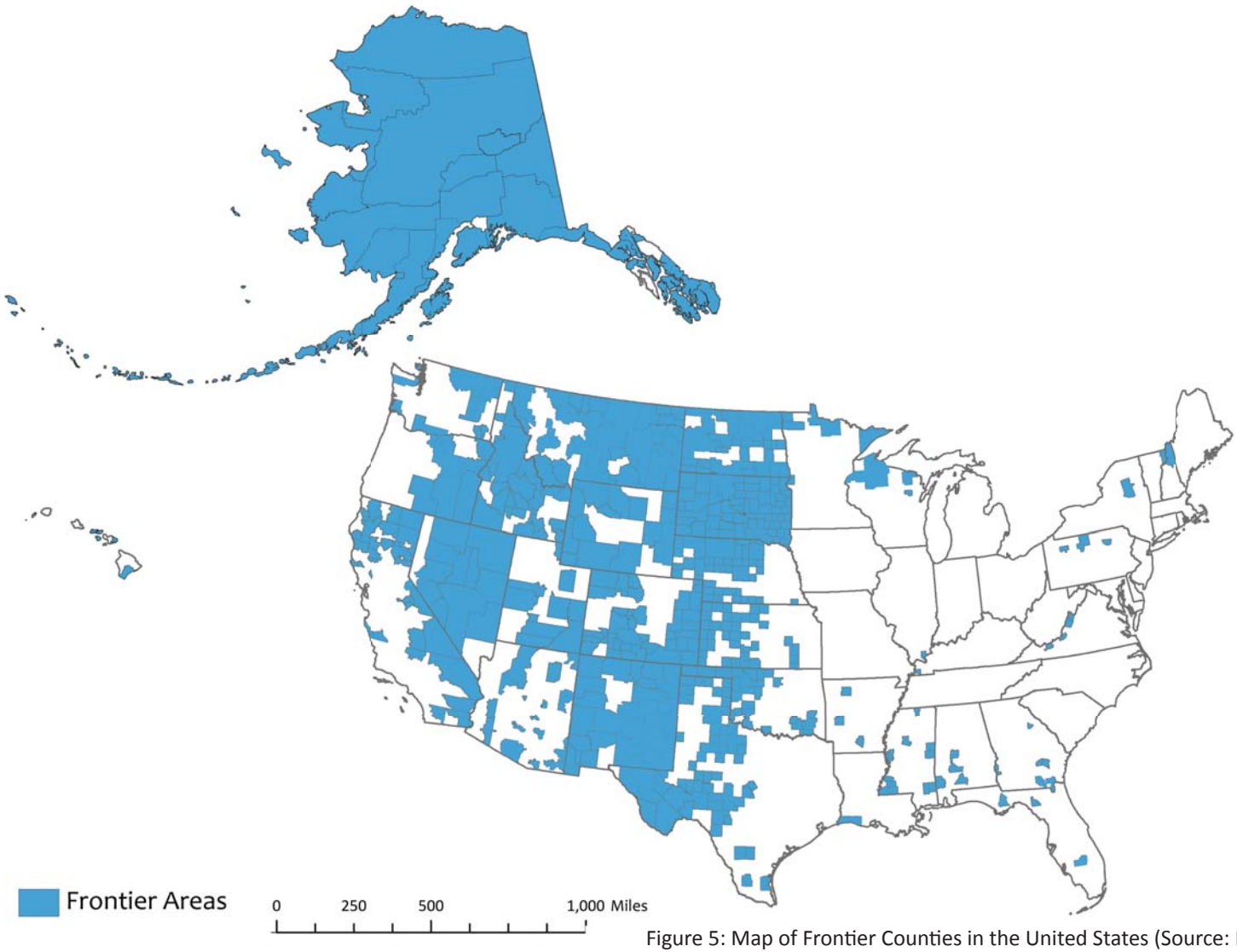


Figure 5: Map of Frontier Counties in the United States (Source: NCFC, 2014, Staloch)

land (NCFC, 2012). These regions are usually “sparsely populated and face extreme distances and travel time to services of any kind” (NCFC, 2007). The average population density for frontier counties is 3.2 people per square mile. Lower population density for residents and patient volumes affect provider distribution and therefore impact access to health services in remote frontier areas. Provider shortage areas cover most of the frontier counties in the United States.

The third criteria for defining a frontier community evaluates the travel time to hospitals considering road conditions, infrastructure, topography, speed limits, and weather variations. Weather conditions for traveling great distances becomes a barrier in many remote areas with extreme cold and blizzard conditions with icy roads in the winter and/or early spring months and by scorching heat and inherent road repairs during the summer and fall months. In addition, “roadways through hilly and mountainous terrain in parts of Wyoming and Montana can become impassable for weeks at a time in the winter” (Stingley, 2014 p. 337). A county is considered frontier if travel time is over sixty minutes to a hospital. Overall, frontier populations maintain natural ties to the region and live isolated lifestyles. Great distances affect their access to services including “long trips to attend school, shop for groceries, get healthcare, and reach other basic services” (RAC, 2014).

Quality rural healthcare: Healthcare in rural communities must be accessible and promote quality patient care with improved outcomes. Rural health must be organized to provide the right treatment at the right time within the constraints imposed by the remote context. Care must be consistent with the optimal desired outcome. Rural organizations reference the United States Department of Health and

Human Services (DHHS) to determine quality care.The DHHS recognizes that “health care is a direct correlation between the level of improved health services and the desired health outcomes of individuals and populations” (Institute of Medicine, 2013). Health quality should be “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge” (RAC, 2014). The summary of quality measures in rural areas should be no different than that in more populated areas and includes patient aims for safe, effective, patient-centered, timely, efficient, and equitable healthcare. Quality is measured by what is perceived to be excellent care and rural medical providers must strive to provide high quality care. It includes patients that are not merely passive recipients of “medical care, but rather the primary source for defining care goals and needs” (CMS, 2014). Optimal healthcare includes patient access, evidence based care provisions, patient safety, support for patient engagement, care coordination, and cultural relevancy.

In rural communities quality care means incorporating all the measures for optimal patient outcomes within the context of the existing setting and with the obtainable resources. Rural healthcare must provide services through the efficient use of health care resources that are available (CMS, 2014). In emergency traumas, rural health services strive to stabilize and accommodate patient needs and transfer the patient for additional care as needed. The patient is only transported when they are stable and there are safe weather conditions.

The diversity and complexity of social and medical conditions in a typical frontier community also

challenges care delivery. Rural residents in many remote communities experience increasingly limited economic opportunities and a higher outmigration of care due to the closure of medical facilities. Rural communities are typically comprised of a large aging population with a strong need for primary care and chronic disease management. In some rural communities a high volume of tourists also need emergent care for unintentional injury and illnesses. Rural residents are more likely to live unhealthy lifestyles and have a greater need for medical services as they age. Rural healthcare providers struggle with promoting healthy living when the population lacks adequate basic health services.

In a study by the Robert Wood Foundation, noncore counties (rural regions within the United States) ranked last in all seven clinical measurements including health outcomes for the length of life, quality of life, health behaviors factors, clinical care factors, social and economic factors, and the overall physical environment for quality healthcare. Rural counties scored in the lowest percentage of population without health insurance and the lowest number of physicians, dentists and mental health professionals available to the county's population on a per capita basis (Marema, 2014).

Improving healthcare starts with attracting and retaining clinicians who are willing to work in rural regions. Many frontier areas are classified as medically underserved because of provider shortages. Rural medical clinics struggle to retain medical providers because of the competitive salary market and the preferred urban lifestyles of experienced health professionals. Many rural communities struggle to attract even a general practitioner and have even more difficulty attracting specialist providers.

Advances in medical technology including electronic medical records (EMRs) and telehealth have improved access to healthcare in many rural and remote communities. Small personal and portable medical monitors and devices are also being employed to an even greater degree in the delivery of rural healthcare. These new technologies are significantly changing the nature of care and how healthcare is delivered. These technologies can be easily accommodated with minimal impact on the design of the physical settings for healthcare. Healthcare settings in rural and remote communities must plan and design to accommodate these changes and anticipate future changes in medical technology.

Research and policies for healthcare often focus on urban areas which result in incomplete understandings of the healthcare issues and needs in rural regions. At a time when critical access hospitals, federally qualified health centers (FQHCs) and other rural healthcare providers deal with changing reimbursement models, frontier rural clinics struggle to maintain financial stability. New architectural settings in these communities must be planned and designed to support evolving operational processes and promote health outcomes within the context of rural communities and their medical, physical, environmental, cultural and social contexts.

The lack of urgent care services, the lack of providers working in underserved communities, the geographical distances between health facilities and unsustainable business models contribute to the growing lack of access to primary and emergency care in rural areas. Further research should focus on closing the gap between distance and emergency situations. Future efforts should measure “the relationship between access to emergency services and outcomes for emergency care” (Carr, Branas,

Metlay, Sullivan, Camargo, & Carlos, 2009, p. 261).Emergency care is important to study because the accumulating access barriers increase the potential for mortality in rural regions.

While it is impossible to alter the geographic distance to care in remote communities through architecture, the design of frontline care clinics in these communities must anticipate and accommodate the unique care needs that distance and remoteness impose. Healthcare must be inherently more self-reliant, efficient and sustainable in order to provide the greatest level of care at the lowest possible cost. At the same time the nature of services should be finely adjusted to the health needs of the communities being served. Research and insightful design of new architecture will promote patient wellbeing for quality care. Architectural precedents and programmatic information developed in this thesis will showcase research that can guide future design strategies in rural areas.

Current Architectural Context

Rural health centers and clinics that successfully support rural frontier areas must be located in accessible physical locations and serve distributed populations in isolated areas. People who live in rural communities lack adequate access to healthcare services due to the distance to facility locations, transportation and, until recently, the lack of medical insurance. Dispersed small facilities must support an optimal level of care similar to their urban counterparts but with limited resources and lower patient volumes. The Affordable Care Act (ACA) is changing reimbursement incentives and is placing new demands on small, rural health centers. Predictions of increased patient volumes for primary care are projected to increase future utilization of rural clinics. This will result in the potential need for increased provider space, treatment space and the accommodation of new practices related to medical home models for these communities. Many outdated facilities in rural and remote communities lack adequate space to provide the increased level of care that is anticipated.

Critical access hospitals (CAH) have historically served the primary healthcare needs of rural communities with minimal inpatient beds and specialty services. CAHs can only have a maximum of twenty-five inpatient beds and they are struggling with a changing reimbursement model for Medicare and Medicaid patients. Reimbursements from the federal government are decreasing with rising care requirements and a growing focus on quality measures that are difficult to meet when operating with outdated infrastructure and chronic staffing shortages. Rural clinics face even greater challenges given they cannot claim reimbursements for emergency care that is delivered outside of a qualified hospital. There is a service and architectural gap that is the result of clinics not being eligible for federal reimbursements for certain services and CAHs with unused inpatient space and lower reimbursements.

Some CAHs have Emergency Medical Services (EMS) that travel and work in extended rural regions around the hospital. These mobile services minimize the response time and distance barriers for rural patients in emergency situations. A minimal number of EMS providers can then better meet the daily medical needs of a dispersed population and respond in a timelier manner. A single EMS unit for one large geographic region may be adequate until multiple traumas at different locations increase the response time for emergent care in frontier regions.

Federally qualified health centers (FQHCs) and other primary care clinics serve outpatient needs in areas without CAHs. FQHCs provide healthcare in an underserved area or to an underserved population and receive enhanced reimbursements from Medicare and Medicaid for their comprehensive delivery of primary care. Reimbursements to FQUCs however do not include emergency care. The Rural Health Clinic (RHC) program intentions are to increase access to primary care services for patients with federal health insurance. They can be public, non-profit or for-profit clinics located in rural areas. To qualify as a RHC organization, they must use a clinician team approach with physicians and advanced care practitioners, be staffed half of the time with a clinician, provide outpatient primary care and service basic laboratory needs. Rural clinics could operate independently or as part of a medical network system. Again, they are not reimbursed for any emergency care. Many rural clinics do operate as urgent care centers to provide the equivalent of emergency care for the region given that emergency services may be many miles away. This underfunded business model places additional financial strains on many rural clinics.

Figure 6: RURAL ROAD (Martel)

DEMOGRAPHICS OF FRONTIER REGIONS

The frontier areas spread across the United States include a larger percentage of the elderly and more severe poverty than the rest of the county. Generally, the increasing aging population in rural areas can be associated with an increasing potential for chronic illnesses. Compared to urban areas, rural populations are more likely to smoke and qualify as obese (Jackson, Doescher, Jerant, & Hart, 2005, p. 146). Therefore, the people in these areas have a larger per capita need for accessible healthcare. Overall demographic make-up of rural areas includes adolescents, adults and elderly that are more likely to live in poverty. The majority of ethnic backgrounds are white, African-American, Hispanic or Native American.

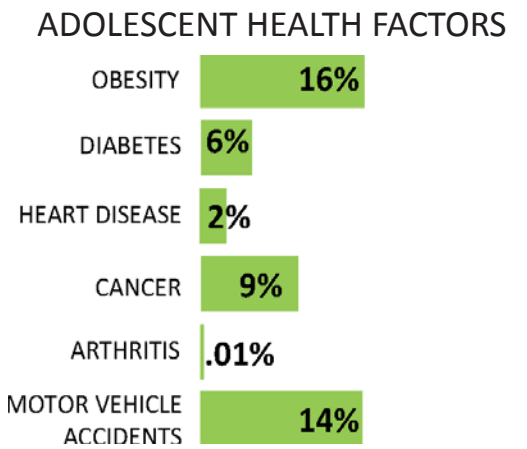


Figure 7: Health Information for Adolescents (Source: NCHS, 2013)

Adolescents: While rural areas are aging overall, adolescents aged 0-18 still account for 23% of the population in rural America (National Center for Health Statistics (NCHS), 2013). They most commonly obtain medical treatment due to motor vehicle accidents or for behavioral health issues. An increasing rate of childhood obesity is leading to type 2 diabetes, heart disease, stroke and osteoarthritis as adolescents' age (CDC, 2014).

Figure 8: Adolescent Obesity (Source: Zimbio)

Adolescents in rural frontier areas tend to use primary care minimally, with the exception of dental services. However, dental services are lacking in many rural communities due to the shortage of dental specialists. It is more difficult to recruit consistent providers to work in the rural areas especially with the overall shortage of providers. Medical systems have begun to consider eliminating all dental care at rural clinics (Otero, 2014). However, some rural clinics provide dental exam rooms or plan for additional dental space.

Depression and other behavioral health issues have increased among youth in rural areas. Many areas lack sufficient access to mental health diagnosis and consequently this leads to greater complications for mental health issues as they age. Additional health concerns arise with untreated mental health. Untreated conditions in rural areas lead to substance abuse which can lead to additional emergency cases for teenagers and adults. Unrecognized and/or untreated mental health matters in young adults can also lead to an increase of self-inflicted harm.

Adults: The largest age group in frontier regions includes adults between the ages 18 - 65. Adults living in frontier regions acquire higher rates chronic illnesses comparable to urban adults. However, in rural areas, adults inconsistently access screening and follow-up healthcare. Adults in rural regions usually begin living with more chronic illnesses at a younger age compared to metropolitan area adults (NCHS, 2013). Prominent chronic conditions include obesity and heart disease.

A national study reported that about 25% of residents in rural areas smoke (Jackson et al., 2005, p. 146). Adults with smoking habits are more likely to be obese compared to non-smoking adults. These unhealthy lifestyles combined with a reduction in physical activity as people age lead to higher accounts of diabetes and hypertension. Treatments and care for diabetes and hypertension require routine scheduled exams and consistent medical appointments. The higher accounts of smoking in rural communities also results in a higher reports of respiratory illnesses and cancers. This necessitates the need for chronic disease management including more frequent scheduled exams, surgery, treatments and monitoring. To control hypertension, adults need regular heart screening and the ability to access urgent care for unknown/unplanned heart episodes. High accounts of heart diseases and congestive heart failure conditions call for easily accessible emergency care.

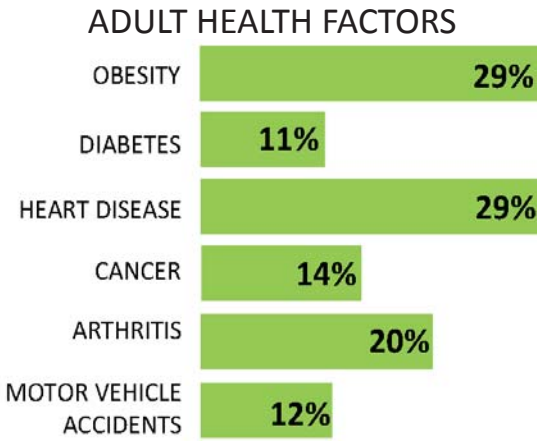


Figure 9: Health Information for Adults (Source: NCHS, 2013)

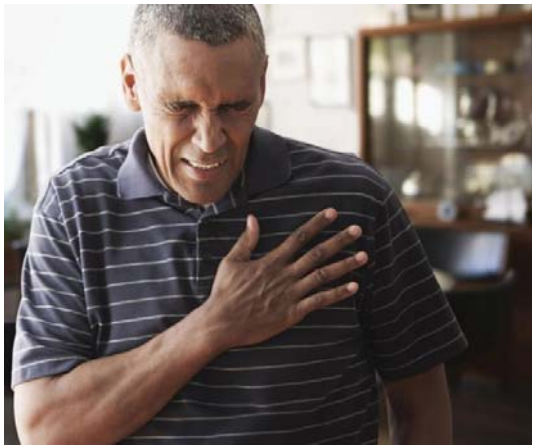


Figure 10: Adults with chronic conditions (Source: Stock/Vetta/Getty Images)

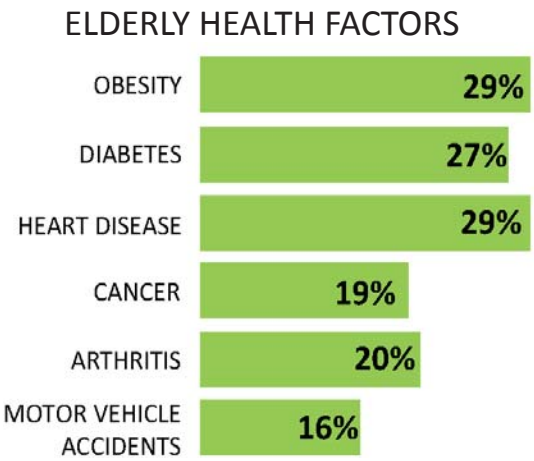


Figure 11: Health Information for Elderly (Source: NCHS, 2013)

Elderly: The largest percentage of elderly in the nation is found in rural regions. People age 60 years or older represent 34% of the population in rural areas (Baker & Dawson, 2013, p. 257) and the population tends to age as rurality increases. 17% of the population of the most rural counties is 65 years or older (Coben et al., 2009, p. 52). This increasing aged populations in rural America leads to increased healthcare needs and a greater number of people living with multiple chronic illnesses. Chronic conditions such as arthritis rise as the population ages and require increased primary care visits.

In small rural counties, injury related hospitalization rates were highest among elderly residents and "unintentional falls were the leading reason for hospitalization" (Coben et al., 2009, p. 51). After receiving treatment for acute injuries, the rehabilitation of elderly adults is prolonged compared to others. Elderly patients have a "slower recovery from acute episodes and increasing prevalence of multiple chronic diseases." These health issues require longer amounts of rehabilitation and health management (Rechel et al., 2009, p. 231). The vast majority of inpatient days in many rural communities involve rehabilitation for long term care patients and there are often inadequate ambulatory and home care services.

Falls in private homes and health centers call for emergency care. EMS must respond quickly and ideally should be located to minimize travel time to nearby medical facilities. Unfortunately many rural communities lack adequate EMS coverage. Within this frontier context, rural elderly that live independently are likely to own pets. Patients may command that their pets accompany them to medical centers. As they become hospitalized, many patients are unwilling to leave their home without

their pet. The maintenance and containment of a patient's animal often falls to the medical center after the patient is admitted and EMS leaves. Rural facilities must plan for animal kennel space near patient treatment or observation areas.

Elderly populations tend to include "mostly women who are in poor health, who live alone, and are poor" (Rogers, 2000, p. 20). Elderly women use hospital services more frequently compared to men. Certain injury risks, such as hip fractures in women aged 65 years and older, cause women to be hospitalized three times as often as men (Coben et al., 2009, p. 52). Rural women who suffer from hip fractures have an increased risk for hospitalization due to inaccessible primary care, the underutilization of hormone replacement therapy, social isolation, and other environmental factors. If primary care services become more available to rural patients, they will become less dependent on additional urgent care.

Figure 12: Elderly in Rural Areas (Source: Diabetes Care)

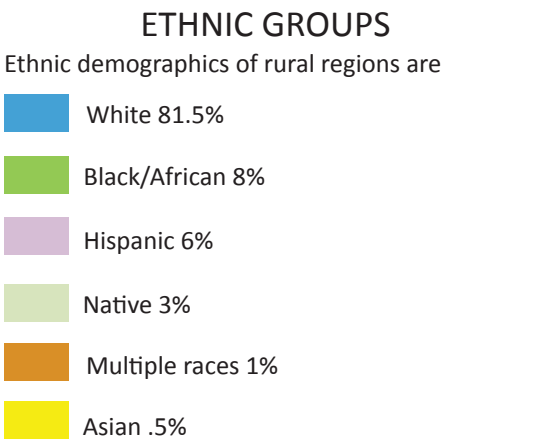


Figure 13: Ethnic Demographic Groups (Source: NCHS, 2013)

Figure 14: Community Gathering (Source: California Indian Education)

Ethnic groups: Ethnic demographics of rural regions predominantly consist of white Americans, black African Americans, Hispanic Americans and Native Americans. Healthcare access for various and at times diverse ethnic groups generates various health factors in each region.

Many rural locations include Native American populations and trends. Indian Health services (IHS) offers Native Americans healthcare access by operating health facilities on tribal land. Rural areas with critical access hospitals serve the native population if IHS is unavailable. IHS provides services such as childcare, safe drinking water, food safety, vectorborne diseases care, and home health.

American Indian and Alaska Native populations are the most rural and most underserved minority populations in the United States (U.S. HHS, IHS, 2014). This demographic group experiences the poorest health status of any racial/ethnic minority in the nation (Burhansstipanov & Hollow, 2001, p. 209). These native populations “experience the worst cancer-related disparities of any minority group, resulting from poverty, lack of access to high-quality continuous care, and infrequent opportunities for health promoting behaviors” (Demiris et al., 2009, p. 129). Many Native Americans acquire serious behavioral health issues that require medical service (U.S. HHS, IHS, 2014). Top health concerns include diabetes, lack of immunizations, mental health issues, obesity and substance abuse. Accommodating Native American traditions can impact the design of health facility environments. For example, spaces for healing should include traditional practice areas that supplement western medical practices. The design features should support native traditions through patient room orientation layout and in some cases separate ventilation for health smudging activities.

Rural poverty: 19% of the frontier populations live in poverty and this is higher compared to urban regions (NCHS, 2013). Impoverished populations tend to be uninsured or under insured. Lower income rates maintain consistent levels of poverty in rural areas. Access to affordable and convenient healthcare impacts rural resident's healthcare and healthy living habits.

According to per capita statistics, the growing elderly population is more likely to be impoverished compared to urban areas (NCHS, 2013). Also, older adults may have lower incomes due to retirement and lack of savings (US Census, 2009). Lower incomes and job availability along with an often higher cost for goods and services contribute to poverty in rural areas. Citizens in rural areas may also be undocumented or independent people living remotely who do not want to be recognized until they need emergency care (CRMC DON, 2014). Limited access to health insurance limits access to healthcare in rural clinics.

The current political shift for all Americans to have access to affordable healthcare insurance provides an opportunity for rural residents to seek healthcare services previously unavailable. The resulting increase in the number of people pursuing primary care includes people who gradually incurred untreated health conditions over time. New insurance coverage expects "to have a larger impact on rural populations because the rate of uninsured Americans in rural areas exceeds that of urban areas" (U.S. Census, 2009). Newly insured patients will potentially seek out rural health clinics for care and temporarily overload both operations and reimbursement models. Expanding insurance coverage may reduce uncompensated care and many rural hospitals must deal with upfront investments in order to

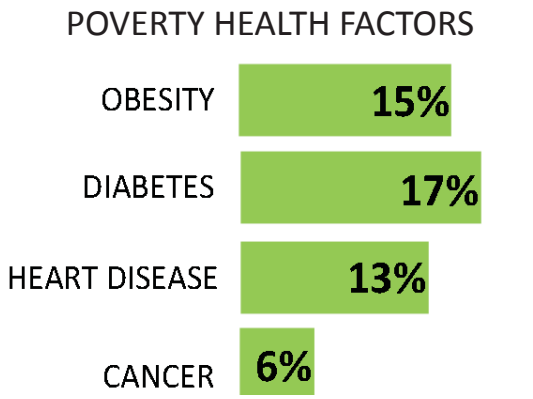


Figure 15: Health Information for Rural Poverty (Source: NCHS, 2013)

Figure 16: Americans in Poverty (Source: Static NYT)

handle the influx of new patients (American hospital association, 2011, p. 9).

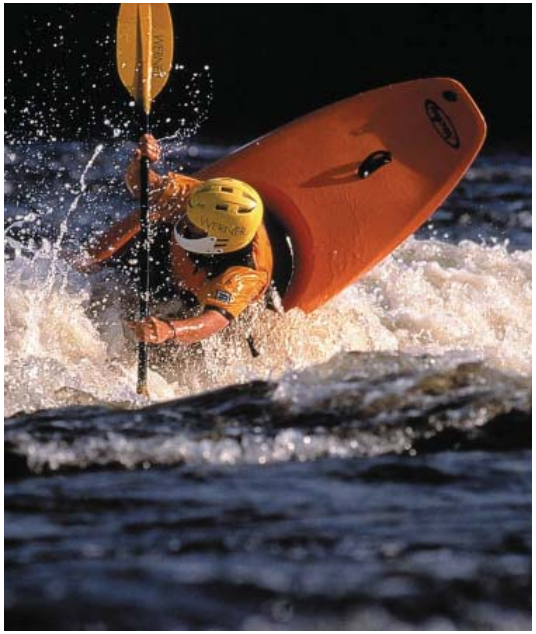


Figure 17: Outdoor Tourist (Source: Bedale)

Tourists: In addition to their resident populations, many rural areas provide a diverse range of opportunities for outdoor adventures and natural retreats for visitors. Some rural communities must accommodate a significant surge in population during tourist seasons. Rural medical services, as a result, must accommodate significant increase in service volume during these periods.

Visitors to rural areas also temporary use rural medical facilities. Rural areas attract adventurous outdoor adventure seekers that could potentially seek emergency treatment for a variety of accidental injuries that are both minor and severe. Common tourist injuries include motor vehicle accidents, falls, broken limbs or flesh wounds. High volumes of tourist visiting emergency units within the tourist season can unexpectedly overload rural emergency units. In an emergency, visitors should be able to locate the nearest medical center in order to achieve optimal quality care.

Figure 18: Rural Aging Population (Source: Medical News)

Figure 19: Tourist Hiking (Source: National Geographic)

Figure 20: Rural Agriculture (Source: HuffingtonPost)

FRONTIER DEMOGRAPHICS PROFILE

Rural citizen demographics include

- Adolescents
- Adults
- Elderly
- Impoverished
- White, African & Native American ethnic groups
- Lack of adequate insurance
- Multiple chronic conditions

Popular tourism activities

- Hiking
- Golfing
- Biking
- Hunting
- Fishing
- Water sports

Accidents from these adventures bring tourists into rural medical facilities.

Figure 21: Alaska Frontier (Staloch)

FRONTIER HEALTHCARE ISSUES

Architectural settings for the delivery of rural healthcare must support improved access to healthcare and promote the delivery of quality care. The literature reviewed for this thesis focused on four topical areas of inquiry: improving accessibility, quality of care, sustainability and cultural relevance.

The greatest barrier for attainable healthcare is not having physical or financial access. Current concerns and discussion on rural health focus on issues of access specifically looking at emergency care travel distances, medically underserved areas with a lack of health providers and the portion of the population without health insurance. Focusing on rural healthcare, research must examine measures of quality healthcare and the needs for optimal patient outcomes. Continued delivery of healthcare in rural areas over time must engage progressive business pattern that can be economically viable. Much of the literature on rural healthcare identifies the need for rural health clinics to overcome inefficient business patterns and move toward sustainable operational and environmental business models. These objectives must also be accommodated with the local culture of rural areas. Small communities hold strong traditions and this study of rural areas accounts for the cultural relevancy of these frontier areas.

A literature review was compiled of scholarly articles in rural healthcare to research the best practices in design for rural healthcare facilities. Research inquiry focused on the thesis question: what are the best practices in the design of frontier clinics that adequately support access to and the delivery of healthcare in remote and rural communities?

Research brought out four main issues relevant to rural healthcare and the architecture of rural healthcare clinics: accessibility, high quality care, sustainability and cultural relevance. Accessible healthcare in rural America covered issues of distance, workforce shortages and access to health insurance. High quality care in rural healthcare included care coordination, evidence-based care along with appropriate and timely care. Sustainability looked at both operational and environmental dimensions. Research in rural areas examined the issues of cultural relevance by first researching the demographics of the regions and then their particular needs for healthcare.

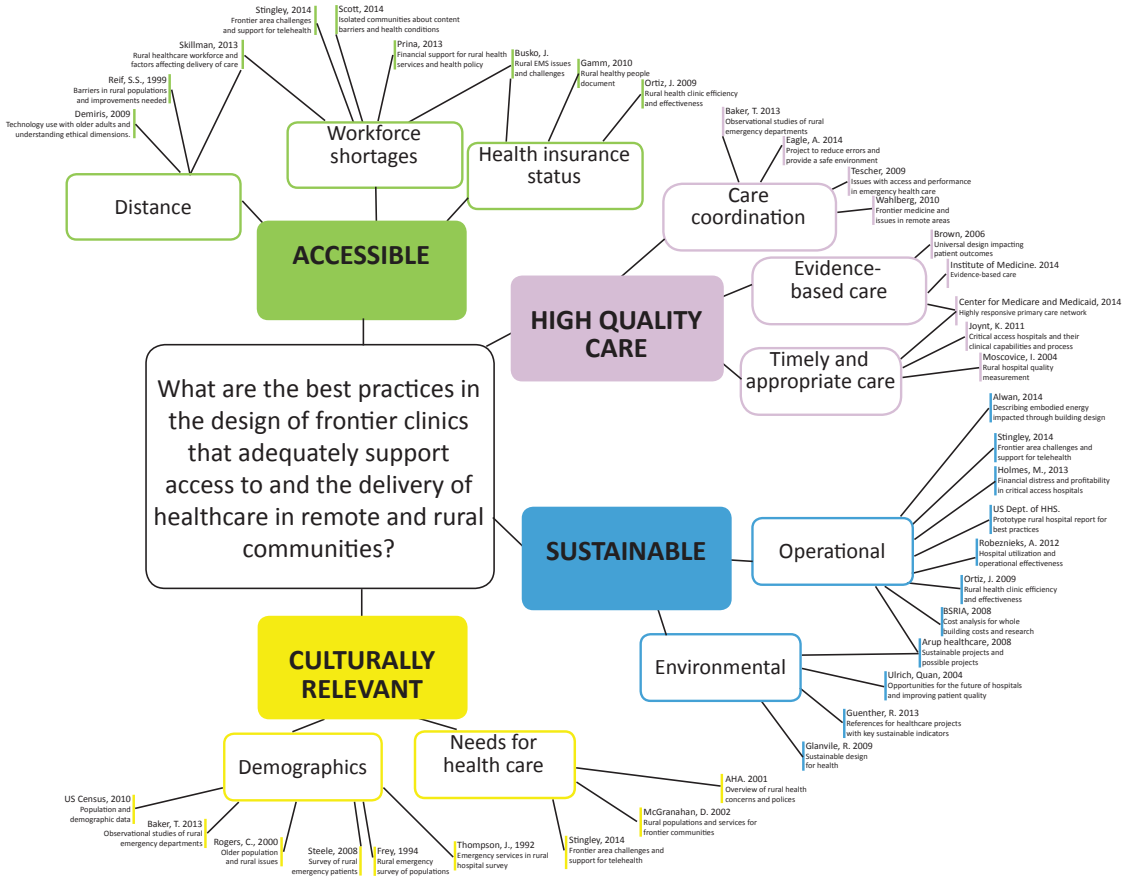


Figure 22: Literature Map (Staloch)

Accessibility

Figure 23: Objectives (Staloch)

Access assessments include geographical distance, workforce shortages and the access to health insurance in the United States. Access to healthcare must include geographical access to a health facility and having access to a professional health provider that is economically attainable.

Distance: Distance to a health clinic is a barrier because of the travel difficulties related to obtaining transportation, enduring the hardships of travel and inclement weather conditions (Reif, Des Harnais, & Bernard, 1999, p. 206). Geographical remoteness limits access to medical care "because of distances to health care facilities, transportation and associated costs" (Skillman, Patterson, Lishner, Doescher, 2013, p. 3). Large distances between towns inherently often involve travel on secondary roads with minimal cell phone reception and passing traffic (Stingley, 2014, p. 337). These obstacles limit connections between remote and widely dispersed populations and the nearest communities and services. The struggles of traveling long distances in remote areas especially impact the most vulnerable members of rural communities such as the elderly, disabled, and the economically disadvantaged (Reif et al., 1999, p. 203).

Patient access to primary care is limited by the location, operational hours and the diversity of health services available. Primary care clinics are generally the first point of care and providers in these clinics work to maintain health for all patient varieties in rural regions.

Emergency care in rural areas is limited by the operating costs of 24-hour health services, low patient volumes and the distance to an emergency department. Clinics struggle to maintain viable 24-hour

Figure 24: Highway System in Alaska (Staloch)

urgent care for regions without emergency departments and without adequate revenue to support ongoing services.Rural medical centers that cannot sustain operations due to the high cost of healthcare are forced to close. Many rural communities experienced hospital closures over the past five years. Forty-three rural hospitals have closed since 2010 and lack of access depletes the remaining services for the people living in these areas (NC Rural Health Research Program, 2015). The greatest impact of hospital closures is the “loss of their local emergency room” (Reif, et al., 1999, p. 202). Emergency department closures increase the distance even further to emergency care for an ever expanding geographic distribution of people who at some point will need these services. Geographical access, travel distance and time become vital in providing effective emergency medical care.

Rural clinic site location impacts possible transportation options and geographical access to healthcare. Site selection criteria should include convenient proximity to other essential services and highway systems. Frontier lifestyles involve more deliberate planning for trips into town so that more than one task can be accomplished during each trip. Therefore the essential services of routine life, including healthcare, should be located in close proximity to each other for convenience. A central location for the largest capture population allows centralized access for patients and visitors to the medical center. The clinic site should be located along major arterial roads to optimize access and wayfinding to the site for people passing through the region. Major transportation arteries are more likely to have clear, dependable year round usability compared to rural secondary roads.

The frontier town of Glennallen, AK located a clinic on the highway system between the ridge of the frontier area and the town center. The site provides access for patients from throughout the region by being located on major arterial roads linking the neighboring towns of Palmer, Tok and the Valdez region. In the summer, its location on a tourist route provides accessibility for visitors who have emergent healthcare needs. Locating clinic sites along major access routes or entries to tourist destinations such as state and national parks can enhance access for both incoming tourists and community members, many of whom may work there or have business connections that benefit from tourist traffic. Fort Providence Health Centre selected a site at the edge of the town near the main traffic roadway. This site is also convenient for trucking traffic passing through during the ice road season.

Figure 25: Glennallen Clinic on the Highway System (Staloch)

In addition to being centrally located for emergent and urgent care, rural health clinics should be co-located with other services that support daily life in the community and region. People who live in remote locations should be able to make a single trip to purchase food, fuel and other essentials with routine visits for primary care. Locating a facility near a community's main node easily provides opportunities for access.

Health services should also be coordinated with local school systems. Rural education buildings located centrally between the communities served by the school can promote accessibility for community members. A collaboration of public services such as education and health should be co-located in frontier areas. Additionally, education and health institutions can potentially share services and processes.

Figure 26: Legacy ER Facade (Source: 5G Studio)

Legacy ER supports user access to urgent and emergency care within the suburban region of Allen, Texas. Considerations for the selected site targeted the local population for their freestanding emergency services. Legacy ER is intentionally located between primary residential areas and the commercial district. The building façade and the location on a corner site were designed to attract the attention of passing traffic. Rural clinics can take this suburban concept and apply it to their setting for a corner location and eye-catching building façade.

Workforce shortages: Work force shortages discourage access to healthcare in frontier regions. Rural reports concluded that 10% of medical physicians serve 20% of Americans who live in rural areas (Busko, 2009, p. 217).

Figure 27: Community Clinic (Source: thecitywire)

Health provider shortages exist across the nation and reach even higher deficits in rural areas. 10% of rural communities do not have a primary care physician (Gamm, Hutchison, Linnae, Dabney, & Dorsey, eds., 2003, p. 46). These communities have no access to healthcare because of provider shortages. HHS secretary, Kathleen Sebelius, stated that “far too many people in rural areas go without care today simply because there’s no one for them to receive the care from” (Prina, 2013, p. 1682). According to the American Hospital Association, “The Health Resources and Services Administration has designated 77% of rural counties as primary care health professional shortage areas” (AHA, 2011, p. 10). The lack of providers greatly impacts medically underserved populations. In addition, health providers serve a larger region and often spend added time traveling to and from multiple facility sites.

Another issue contributing to workforce shortages is the growing mix of providers who are either approaching retirement or are recently graduated physicians. Recent graduates are initially drawn to rural communities because of federal policies that reduce or forgive student loans for service in medically under-served communities. Many health providers who grew up in rural communities or have worked in rural areas over their career continue to age and they are likely to retire within the next ten years (National advisory committee on rural health and human services, 2015). The challenge in both cases is the long term retention of experienced care providers. Recently educated physicians choose to receive temporary work offers in rural regions to gain practical experience. As a result, rural area medical physicians as a whole tend to be younger than urban physicians (Reschovsky, & Staiti, 2005, p. 1130). Therefore, they tend to have less experience and need access to additional opportunities for continuing education and advanced training. Serving in rural areas limit provider "educational opportunities to become a health care professional, and to upgrade skills and pursue professional development" (Skillman et al., 2013, p. 3). Rural medical systems must find ways to continue to support education and the retention of medical providers (Scott, Menzies, Chenard, & Spence, 2013, p. 165). To keep healthcare providers is a growing difficulty (Reif et al., 1999, 203). Additionally, rural health organizations strive to find new incentives to attract clinicians to serve the region such as provider housing or more paid time off. New policies and telehealth measures strive to overcome health provider shortages.

Figure 28: Nurses Required (Source: Cloudfront)

Advanced care practitioners increasingly compensate for the shortage of primary care physicians. The proportion of nurse practitioners in 2012 increased 10% adding to the accessibility to healthcare (Ortiz,

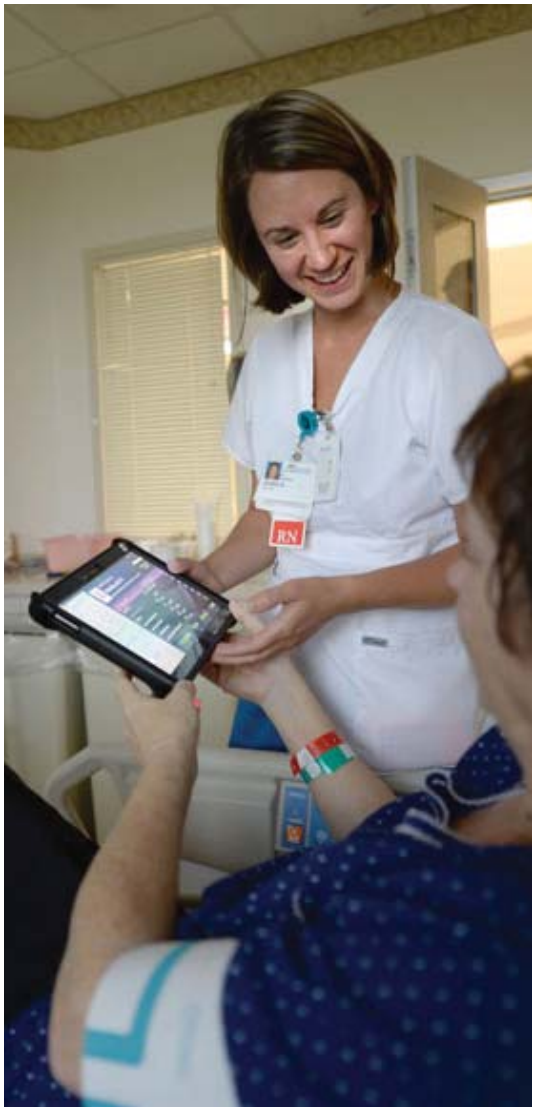


Figure 29: Workforce with Telehealth (Source: High Ground)

Meemon, Zhou, & Wan, 2013, p. 363). Even with the increase, only 15% of nurse practitioners work within rural locations (Skillman, Kaplan, Fordyce, McMenamin, & Doescher, 2012 p. 8).

The Centers for Medicare and Medicaid Services (CMS) issued a proposal in February 2013 that may reduce the provider shortage burden on critical-access hospitals, rural health clinics, and federally qualified health centers. The policy plans to do this "by eliminating the requirement that a physician be held to an excessively prescriptive schedule for being onsite once every two weeks" (Prina, 2013, p. 1682). This policy would allow more flexibility for providers to minimize their time of physically be in the frontier clinic. The main objective of the law eliminates geographical barriers through improved telehealth expansions to provide care at a lower cost. The goal provides more telehealth appointments without a physician onsite as an alternative approach for providing quality care. The potential cost savings could allow for expanded distribution of resources. However, this proposed rule has not yet been implemented.

Rural medical centers increasingly use technology to bridge the distance between dispersed populations and providers. Communicating with another site or provider through digital technology allows viewing and responding over video or phone conversations. Telehealth employs "videoconferencing or other telecommunication technologies to enable communication between patients and health care providers separated by geographical distance" (Demiris, Doorenbos, & Towle, 2009, p. 129). Patients and providers can communicate electronically within the same building or in different cities. Regional health systems and independent clinics use telehealth for specialist consults and follow up chronic care exams. Many

CAHs provide adaptable telehealth rooms for these consultations. They use technology for diagnostics and to improve and simplify the access for patients. Providing monitors and connection to technology within clinical areas minimally alters the space and requires minimal alterations to the facility.

Critical access hospitals commonly outfit telehealth rooms to serve a variety of patients. Ely-Bloomenson CAH built rooms with telehealth capabilities for any specialty. Patients use the room with a medical assistant and communicate with a remote physician through video and audio conferencing. Alternatively, some rural facilities provide telehealth systems on mobile carts that can move between several on-site exam rooms and provider offices. Fort Providence Medical Centre employ telehealth equipment that transfers between providers as it is needed. This requires the design of larger provider offices to facilitate patient telehealth meetings with medical assistants and connections with a specialist via monitor.

Rural clinics can also utilize mobile imaging units that are transported via truck or specially designed vehicles and connect onsite to the medical building. These units allow for patients to receive imaging services with minimal travel to a regional medical center. CAHs in Idaho collaborated to purchase a mobile magnetic resonance imaging (MRI) unit to travel between six sites multiple times per week. They can each scan hundreds of patients a month without requiring patients to travel farther distances (Smith, 2013). To accommodate mobile units, rural facilities must plan for an accessible site for the transport unit to connect to the facility for sheltered access and utility links to the building.

Figure 30: Mobile MRI (Source: Monett times)

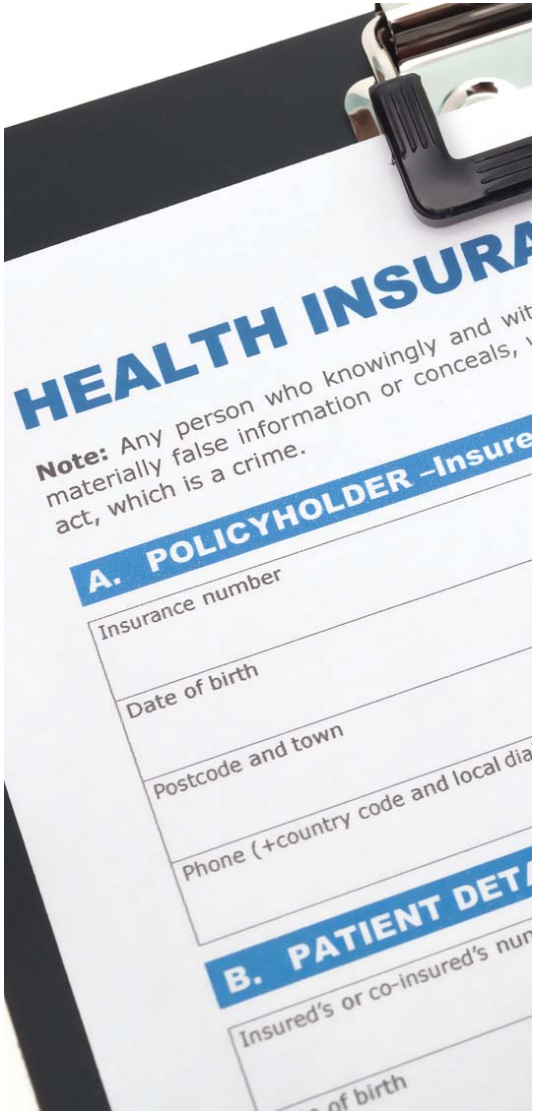


Figure 31: Health Insurance (Source: Cloudfront)

Incentives to attract and retain providers in rural settings often mean offering housing provisions. Medical provider housing for students and visiting clinicians then becomes a form of payment for rural health centers. Physician apartments provide living areas and additional benefits for serving in remote areas (Stingley et al., 2014, p. 337). Some clinicians fly into work for four to six weeks and then return to their permanent home between monthly shifts. Temporary housing for clinicians to use during their work shift makes them more available and enables them to spend less time commuting to and from work and home.

Medical providers in frontier areas must be enticed to work under challenging conditions and often live for periods of time away from home. Rural medical clinics must also accommodate providers who rotate around the region or between several facilities. The majority of case studies for this thesis provided staff housing off site but near the facility. Fort Providence, Canada incorporated clinician housing on the second level of their medical building to accommodate rotating clinicians. Clinicians are more willing to work on call while they are in the frontier areas when residing in organizational housing. Providers may come by airplane and do not have daily transportation. Therefore, housing sites must be located within close proximity to work, the activities of daily life and whatever transportation is available to them.

Access to health insurance: Rural residents are more likely to be uninsured and lack third party insurance (Gamm et al., 2003, p. 19). Access to medical care diminishes for patients who do not have health insurance either through public or private sectors. Patients in rural areas are more likely now to obtain health insurance with ACA polices. Patients that previously did not seek medical attention because of

lack of insurance will now need to be accommodated.

As health systems continue into the future, “public funding is likely to be a more important determinant of the financial and operational health of small, rural hospitals” (McNamara, 2009 p. 6). A decrease of Medicare and Medicaid reimbursements continues in rural areas and the effects of the ACA negatively impact operational efficiency. Many rural medical clinics must survive on 60% of their revenue from public programs (Avalere Health, 2009). Rural health centers that provide 24 hour urgent care because they are the only caregivers in the region have difficulty being reimbursed for care from public health insurance. Clinics are not reimbursed for emergency care from Medicare and Medicaid because they are not qualified to be 24-hour emergency departments. Rural health federal funding does exist to a limited degree to support general rural healthcare and as a result many rural clinics compete for the same federal health grants.

Rural clinics must accommodate newly insured patients and assist them with any health issues that they gradually acquired over time. Rural facilities must accommodate a growing surge of primary care patients with optimal quality care. ACA regulations strategize for patient and operational satisfaction within the facilities including improving efficiency, promoting safety, stream lining operations, reducing distractions and eliminating waste. Frontier clinics must also meet these regulations in their health settings.

Figure 32: Waiting Room (Source: Westernfree)

Improving quality of care

Delivery of healthcare in rural areas must be quality care. Quality care includes care coordination between providers, evidence-based care and delivering the right care at the right time in the right setting. It is the positive correlation of improved health and the desired health outcome. Quality healthcare comprises perceived adequate care evaluated through care coordination and primary care needs.

Care coordination: A high level of care coordination is part of providing quality healthcare and leads to improved health outcomes for people seeking primary care. Maintain care coordination and promote health in rural areas through timely, ongoing, and accessible healthcare. Timely care involves, among other things, the “golden hour” physicians’ use as a goal in treating emergent cases which follow traumatic injuries. Medical attention within one hour likely decreases potential death from trauma. This can be particularly challenging given the distances in rural areas and time it may take for emergency responders to arrive. Health providers must coordinate care during traumas with EMS and available on-call staff. Care coordinators must be able to assess any situation, emergent or routine, for timely care in order to provide optimal patient outcomes.

Ongoing care includes timely and regular screening and examinations to track and treat chronic illnesses. The shifting health conditions within rural regions must accommodate changing healthcare needs. Populations with chronic conditions must access ongoing care for quality outcomes through preventative measures whenever possible. Examination and follow up care be coordinated between multiple transitional providers who may rotate through a clinic.

Optimal care coordination incorporates care teams of patients, providers, and specialists. All team members must maintain current electronic medical records that are on consistent platforms across all providers. In rural areas care coordination begins with the patient's knowledge of personal health. This process starts with the patient's education about their health conditions and continues through health professionals to fill in the gaps in the patient's knowledge or understanding. In workforce shortage areas, clinicians must coordinate care across a team of extenders and each care extender must work to the top of their professional capabilities before referring the patient to the next level of care. This process reflects ideal patient care coordination "across people, functions, activities, and sites over time so as to maximize the value of services delivered to patients" (Shortell, Gillies, & Anderson, 2000). Eliminating physician time with patients decreases medical cost. Rural clinics need to allow staff to work to their highest practice level and delegate physician time to optimize the treatment process. Through quality care coordination, managed care can lead to less acute presentations in the future. Care coordination results in less face time with physicians and adds savings in time and resources for rural health centers (Baker, & Dawson, 2013, p. 256).

Growing hospital systems continue to capture smaller facilities and expand care coordination with primary care and specialist providers. "Frontier hospital networks" introduce new possibilities for health systems to optimize patient care. They also benefit more from available federal funding to compensate for potential loss in funded or underfunded care (Wahlberg, 2010). These networks can coordinate together to more efficiently deliver care for rural populations.

Figure 33: Patient Communication (Source: HCD)

Figure 34: Team Collaboration Space (Source: AIOHome)

Communication technology can also support care coordination between remote clinicians (Eagle, 2014, p. 18). They use telehealth features and EMRs to connect patients and providers across remote distances. Working with technology coordination can "efficiency ha[ve] the highest relative positive association with cost efficiency" (Ortiz, Meemon, Tang, Wan, & Paek, 2011, p. 678). Allowing technology to accomplish the work through records, communication and procedures reduces the overall business expense associated with delivering high care across vast distances.

A growing need arises for additional collaborative space for team home health networks with care coordination. Fort Providence Health Centre provides team collaboration spaces for two to three care providers that accommodate the home health needs within the region. The open work space for these providers is based in the local clinic located near the central clinician area and registration. Rural clinics should provide efficient collaboration for home health providers that may not necessarily be involved with daily treatment within the facility but still part of the population healthcare.

Evidence-based care: Through evidence-based care, quality and safety yield more effective outcomes (CMS, 2014). Rural health providers can promote quality care by creating an environment that promotes healing, safety and minimal harm to patients. This in turn can lead to the reduction of additional and unfunded costs associated with patient harm. Best practices for care in rural areas concentrate on improving in staff environments.

The design of work environments can influence staff satisfaction and the overall quality of care. Staff

satisfaction is highly important in rural areas for retaining providers

Quality clinician work spaces should include day lighting in work areas, minimize circulation and place work areas adjacent to patient care support spaces. Day lighting and access to natural elements supports staff wellbeing and promotes positive work settings. Minimizing the distance between support space and work space allows staff to work efficiently in one location. Connected staff areas increase also increase continuous visibility to patients.

Quality patient care involves reducing or eliminating medical errors and medical infections. Clinician work zones should promote hand washing to minimize infections. Reduce the likelihood of staff medication distribution errors through designing adequate lighting in medication dispensing areas to assist in identifying medication.

The right treatment at the right time in the right setting: Healthcare should not be passive and quality care should actively addresses patient safety to reach effective outcomes (CMS, 2014). Rural medical clinics should provide the best care possible within their setting and focus on providing primary healthcare. However they should be able to deliver care beyond their intended scope as needed to serve any unexpected health needs of the community.

Figure 35: Medicine Dispense Area (Source: WCSStore)

Figure 36: Rural Trauma Room Setting (Staloch)

There is limited research on rural healthcare compared to urban health studies. Specifically looking at current rural health measures “can lead to confusion about what and how to measure quality” especially with a low patient volumes (Moscovice, Wholey, Klingner, & Knott, 2004, p. 383). Recent research concludes that many issues hinder the evaluation of rural CAHs and these same constraints apply to rural clinics. Data is often lacking on the qualifications of clinicians, the role of patient choice in patterns of care and the reliance on Medicare fee-for service outcome data which may not necessarily be the true assessments for Medicare patients (Joynt, Harris, Orav, & Jha, 2011, p. 51). Quality data for rural health can be unreliable because of the lack of records since they “are exempt from reporting to both the Joint Commission performance measure program and the Hospital Quality Alliance (HQA) national public reporting program” (Joynt et al., 2011, p. 45). Additionally, rural processes differ for transferring information between independent clinics and newly acquired facilities in the current system. Overall reports for quality scored CAHs “significantly poorer performance on process measures, which may be due to fewer resources to devote to quality improvements” (Joynt et al., 2011, p. 50). The research results did not account for fewer resources. These issues apply to all rural healthcare providers and settings.

Sustainability

Maintaining a rural medical facility includes both viable operational and environmental sustainability. Operational processes for rural clinics and the delivery of their service needs to employ progressive business model that works within the expectations for rural populations for other frontier services. The medical center's economic status impacts the architectural response to the construction and planning of any rural clinic. Design features should support the intent to eliminate unplanned energy interruptions and incorporate the goals for a better environment to sustain the viability of the facility.

Operational sustainability: Rural healthcare facilities must be designed to maintain economically sustainability and support lean business processes in order to remain in business. Rural clinics must work within their margins to maintain economic viability to continue serving their communities and cannot sustain operations with poor financial management. Economic sustainability comes from increased productivity, access to efficient patient transportation when services are unavailable, maintaining a viable operation and making practical decisions (Rechel, Wright, Edwards, 2009, p. 244). These financial impacts direct the potential resources available for continued access to healthcare in rural areas.

Capital efficiency, as related to operations, comes through the ratio of medical service capital cost in comparison to the expenditures made to operate and maintain the facility. Cost efficiency measures "the inverse of the total allowable cost of the RHC operations per total number of visits rendered" (Ortiz et al., 2011, p. 672). Clinical efficiency supports healthcare business operations over a period of time. The true conditions for optimal efficiency minimize redundancy and provide support for future unforeseen changes. Rural clinics must strive to accommodate future changes through innovative care

Figure 37: Clinical Work Space Efficiency (Staloch)

processes and design flexibility. Therefore the proper planning of rural healthcare facilities must reduce space needs and condense functions into fewer multiple use spaces.

Currently, many rural hospitals and clinics struggle to operate with capital efficiency. Maintaining a strong financial statement becomes difficult with the low reimbursements for services and a low service population. Research in the cost inefficiency of CAHs compared to that of prospectively paid rural hospitals revealed that CAHs function with 5.6% more cost inefficiency (Fannin & Nedelea, 2013, p. 2). Maintaining a strong debt to asset and income ratio is an ongoing problem for rural health operations. Similar to the struggles of health clinics, CAHs maintain meager performance measures with their consistent debt. Up to 50% of CAHs reported to be in debt between 2004 and 2006 and long term debt continues to plague rural medical systems (Pink, Holmes, Slifkin & Thompson, 2009, p. 63).The burdens of debt and income ratios also apply to the current business patterns for rural clinics. Independent clinics have a more difficult time collecting reimbursements because of the lack of qualifications for the clinical services through federal insurance.

While rural healthcare providers struggle with inherently less efficient operations, medical service costs also remain higher for patients in rural areas. Reports concluded that frontier patients were charged more for an injury involving hospitalization compared to patients living in large urban areas (Coben, Tiesman, Bossarte & Furbee, 2009, p. 53). Rural patients who can afford to pay for care or who have good health insurance must compensate for the rural clinic's need to cover expenses across a minimal volume of patients and low Medicare and Medicaid reimbursements. This is especially necessary since

a higher percentage of public sources include Medicare. Therefore the design of rural healthcare facilities must address operational efficiency as a way to reduce the overall cost for providing care over time.

Rural hospitals and clinics must strive to keep up with constant changes. According to Worley and Lawler, operations in rural clinics must sustain viable business models by three aims (Worley & Lawler III, 2010). Aims for business models include economic logic, a future-oriented focus and flexible intentions. Economic logic focuses on the pace of effective economic changes "through momentary advantages and the speed [of change]" (Worley et al., 2010, p. 195). Considering the future implications for business, Worley and Lawler suggest "to develop potential alternative futures and create a variety of short and long term scenarios" (2010, p. 195). Clinics should plan for a variety of business possibilities and future operational patterns. Rural clinical business models must continue to provide adequate service functions while considering other expenses for business (Worley et al., 2010, p. 195). Planning for the future looks at the whole lifecycle costs of delivering services.

Whenever it is possible to build a new facility it should be planned for whole lifecycle cost and the operating maintenance over the life of the capital investment. Rural clinic design and "any new hospital will need to incorporate sufficient flexibility to accommodate the many changes in clinical care" (Rechel et al., 2009, p. 236). Ongoing costs of the building, energy and maintenance all need comprehensive operational planning over the life time of the facility.

Figure 38: Locum Tenens Blog Advertisement (Source: Staffcare)

In order to overcome the struggles of unsustainable business models, rural health enters must employ successful revenue generators. They need to target realistic service lines and provide spaces that can accommodate commonly profitable services. Rural clinics need to optimize businesses similarly to other rural services and create streamlined processes to support capital efficiency and focus on the larger mission (Community Tool Box, 2014).

One way rural clinics can optimize operations is through a calling service for physicians. Physicians referred to as “locum tenens physicians” work in standard environments and substitute at rural clinics that do not have physicians (Stingley et al., 2014, p. 337). They help compensate for the shortage of clinical care providers in medically underserved areas. Clinicians who rotate through community clinics on a scheduled time period can provide care and minimizes the total cost to hire full time employees.

Maintain sustainable healthcare operations model through efficient and effective health delivery. Design efficiently starting with reducing any redundant spaces within a rural facility. Minimal staff areas in frontier clinics must condense to a single support space for each purpose. Cook Hospital is a rural CAH that shares staff support space between the emergency and the inpatient care units. The design includes separate patient areas and shared rooms for the staff dictation, housekeeping, clean linens and soiled materials.

Environmental sustainability: To maintain access, facilities and operations must be sustainable in

terms of energy use over time. Viably sustainable options in remote locations must be environmentally conscious and support the overall energy savings of a building.

Employing alternative forms of energy generation is especially important in isolated regions. Dependence on one form of energy generates possible risks if that energy becomes unavailable or increasingly expensive. Frontier areas may have unreliable access to the electric energy grid and therefore opportunities for employing alternative forms of energy take on even greater importance in remote areas. Designing for natural, sustainable energy sources minimizes the need for the relatively higher cost of transportation and use of fossil fuels. Sustainable energy systems include geothermal, wind, solar, and methane energy systems. In addition, rural areas should employ efficient water resource strategies into the buildings especially in dry arid climates. Therefore it is important to save water in storage systems such as ponds or tanks and minimize unnecessary water use.

In addition to promoting environmental sustainability, environmental energy alternatives can serve multiple purposes and improve patient satisfaction and wellbeing. Rural facilities that incorporate solar energy and use daylight to minimize the energy cost will also improve patient health. Studies strongly reported that light can improve health outcomes such as depression, agitation and sleep (Ulrich, Quan, Zimring, Joseph, Choudhary, 2004, p. 20).

Figure 39: Water Collection Tank (Source: Earthtimes)

Figure 40: Protea Health prototype (Design team: Farrow Partnership, Ngonyama Okpanum and Clark Nexsen)

Solar energy is a viable option in buildings in many rural areas to produce renewable energy and dispense it for use within the building. Protea Health is a South African healthcare facility model for rural communities designed to collect and use solar energy throughout the primary care facility. The design incorporates the acquired solar heat from the sun and transfers it into recovered energy fuel cells to operate the medical clinic.

Culturally Relevant

Culture and community aspects significantly impact the way rural populations seek out and receive healthcare. Attachment to the community strengthens rural relations and creates a sense of belonging. It is when there is an understanding of the culture that people sense ownership and involvement in community projects such as local health clinics (Brehm, Eisenhauer & Krannich, 2004, p. 409). When the community is engaged it develops social and natural attachments with the place. Pride in the feeling of belonging to a community also contributes to individual well-being as "humans are constituted by social relationships found in community" (Kusel, 2003, p. 93). Community and collaboration naturally creates a human sense of belonging. Rural clinics need to collaborate as community partners and know their constituents within a small population.

Identity and culture: In the United States 5,640,793 people live in frontier areas that are mostly medically underserved and lack adequate access to medical care (NCFC, 2007). To summarize the characteristics of frontier demographics, the region includes a decreasing population, aging demographics, increasing poverty, limited health insurance and higher accounts of illness and chronic conditions. People, especially young adults, continually move away from frontier regions. In one decade "two of every three low-amenity frontier counties, population loss exceeded 5 percent" (McGranahan & Beale, 2002). As people leave these areas businesses and services struggles to retain customers and remain viable.

The American Hospital Association reported that "rural residents tend to be older, have lower incomes and are more likely to be uninsured that residents of metropolitan areas" (AHA, 2001). This larger group of aging population requires more frequent medical visits than younger adults and convenient access to

healthcare. Consistent medical appointments and health management for chronic illnesses associated with aging and hard frontier lifestyles necessitate the need for primary care services to be available for the residents remaining in rural areas.

Access to both primary and emergency care: Patients continue to live with multiple chronic illnesses and need primary care to optimize wellbeing. Improving the ratio of scheduled primary care visits allow access to ongoing wellness, monitor conditions and follow up care.

Trends in health issues in rural areas also include increased accounts of health conditions related to alcoholism and smoking, illnesses from obesity, cerebrovascular disease (which is 1.45 times higher in non-metro areas), hypertension and mental health problems. Rural medical centers must provide access to healthcare to

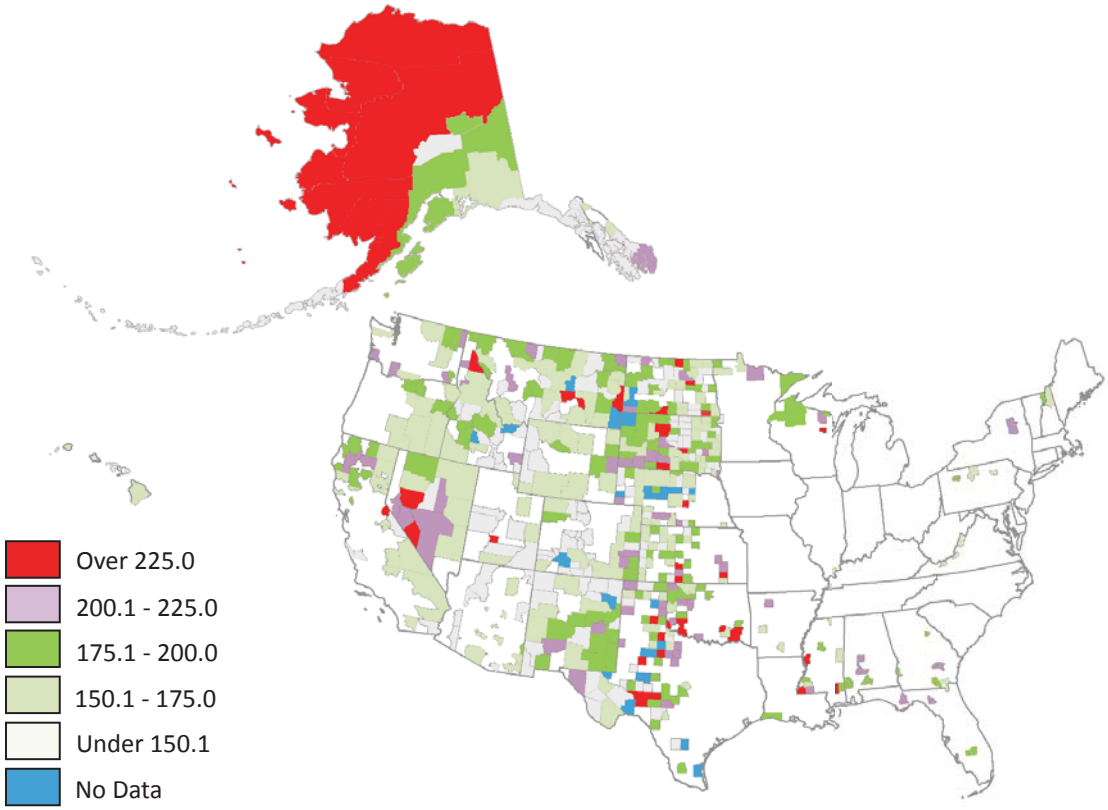


Figure 41: Cancer Mortality rates per 100,000 (Source: CARES, 2011). Cancer mortalities in rural areas are more prevalent in certain pockets of the nation.

treat conditions associated with these lifestyles. Residents in rural areas tend to have multiple conditions that lead to more medical care needs. In rural areas “nearly half of rural residents report having at least one major chronic illness, and chronic disease such as hypertension, cancer, and chronic bronchitis are up to 1.4 times more prevalent” (AHA, 2011). These patients that suffer from these chronic conditions may be unable to travel long distances to seek medical attention. Rural regions also tend to have a higher percentage of obese populations accounting for 36% of adults in rural areas of the United States (CDC, 2014).

Common health needs in rural clinics account for the majority of patient visits. 52% of general healthcare visits were for medication distribution (Baker et al., 2013, p. 52). Pharmacies are rare in frontier areas and the medical center is likely the only source for medications in the region. Rural

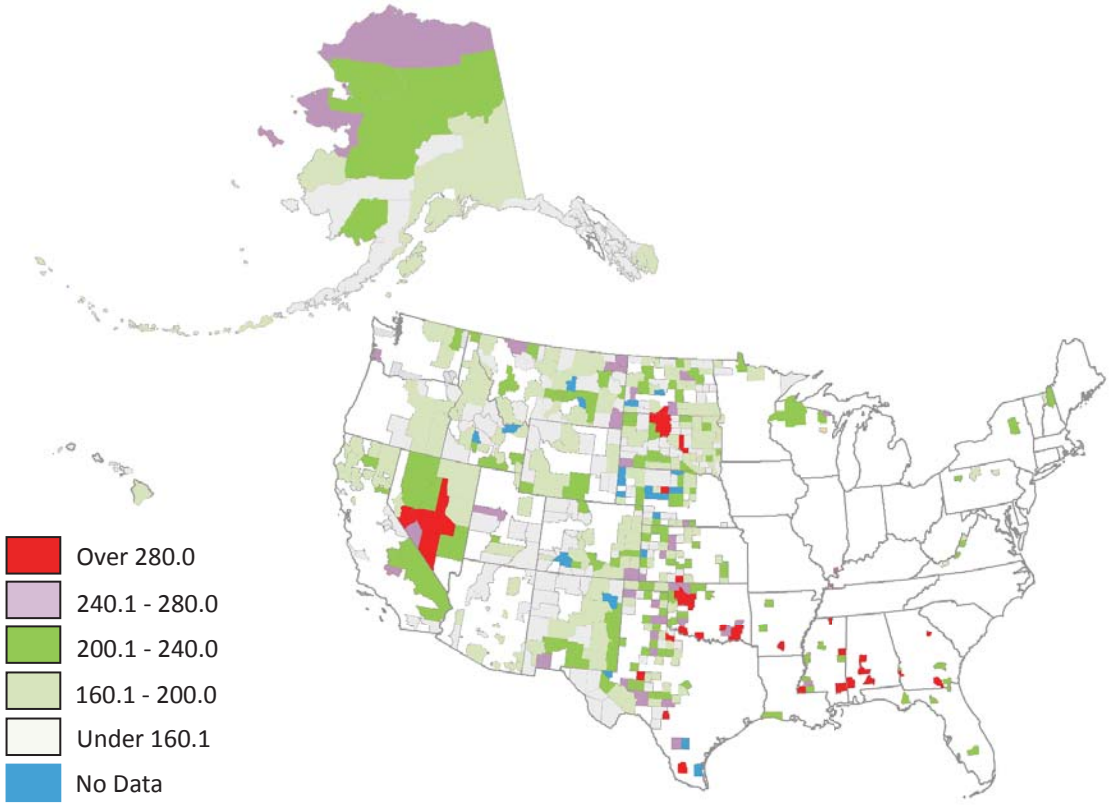


Figure 42: Heart Disease Mortality rates per 100,000 (Source: CARES, 2011). Heart disease is a common health concern in rural areas similar to rising trends in urban regions.

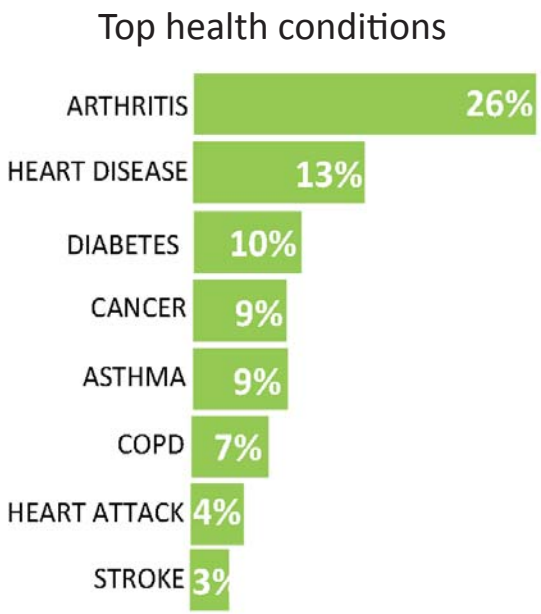


Figure 43: Most Common Health Conditions for People over 18 (Source: NHIS, 2012)

patients reported only using laboratory tests 1.3% of the time and ordered x-rays 6% of the time (Baker et al., 2013, p. 52).

The lack of consistent access to healthcare due to distance and insurance leads to an increased number of health conditions treated in emergency units. Common nursing procedures done in emergency units accounted for 27% of patient visits involving dressings and suture removal. Other common conditions that could have been classified as outpatient included 24% of reported visits for monitoring (such as blood pressure measurement and urinalysis) by nurse providers, 16% received medication, 11% needed orthopedic procedures and 11% were elective treatments (Frey, Schmidt, Derksen & Skipper, 1994, p. 38-42). In addition, clinicians distributed necessary medications, preformed small procedures or referred the patient to another medical center. These common procedures in rural urgent care units indicate an increased need for primary care services to minimize the cost of treating outpatient procedures in emergency units.

Urgent care can provide patients with the necessary care at the right time. In a rural study of nineteen rural facilities “injury was the most common cause for presentation” (Baker et al., 2013, p. 256). The more severe emergency cases include cardiovascular and neurosurgical complications. Frontier clinics may have limited resources for total treatment capabilities but the alternative is no healthcare.

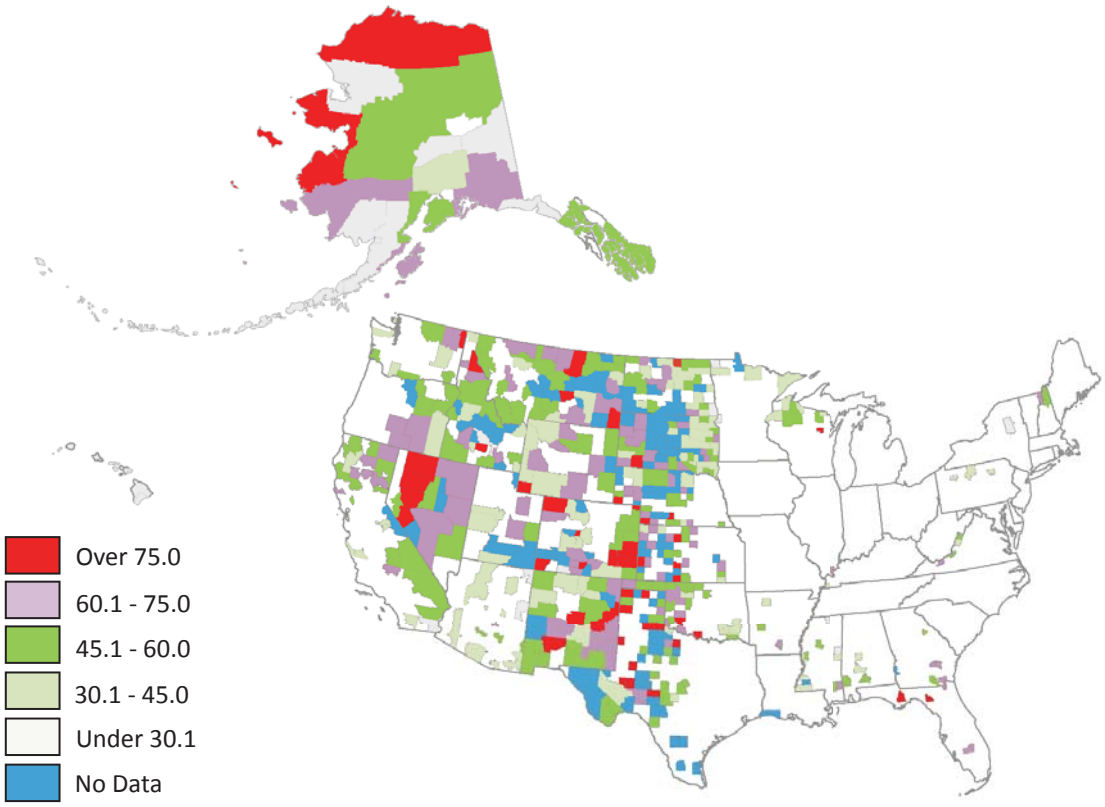


Figure 44: Chronic Lower Respiratory Disease Mortality rates per 100,000 (Source: CARES, 2011). Mortality rates from respiratory disease are increasing within frontier counties.

When emergency care is needed, the lack of access increases the total hospitalization rate and mortality for citizens in rural areas. A study on rural classification of hospital admission rates estimated 1.9 million injury-related hospitalizations in one year and "injury-hospitalization rates generally increased with increasing rurality" (Coben et al., 2009, p. 49). The most common condition for hospitalization in rural populations is unintentional injury from motor vehicle traffic, falls, and poisonings. Low traffic volumes combined with minimal road maintenance leads to higher risks of vehicle accidents in these areas. Higher accident totals dictate an increased need for emergency care (Coben, Tiesman, Bossarte, & Furbee, 2009, p. 51). Studies concluded that rural counties maintained higher rates than urban areas for self-inflicted injuries, poisonings, cuttings, and firearms. Hospitalization rates are higher in frontier areas on a per capita basis. Research

studies report a 27% hospitalization rate in large rural counties and 35% more hospital admissions in small rural counties (Coben et al., 2009, p. 51). According to the Rural Assistance Center and the National Rural Health Association, 60% of total rural accidents result in death or serious injury compared to the 48% in urban areas (RAC, 2014).

Distance and travel time impact the access to healthcare from the frontier region. Frontier clinics may commonly serve primary care health but the operations must plan for emergency care that is necessary for the rural setting.

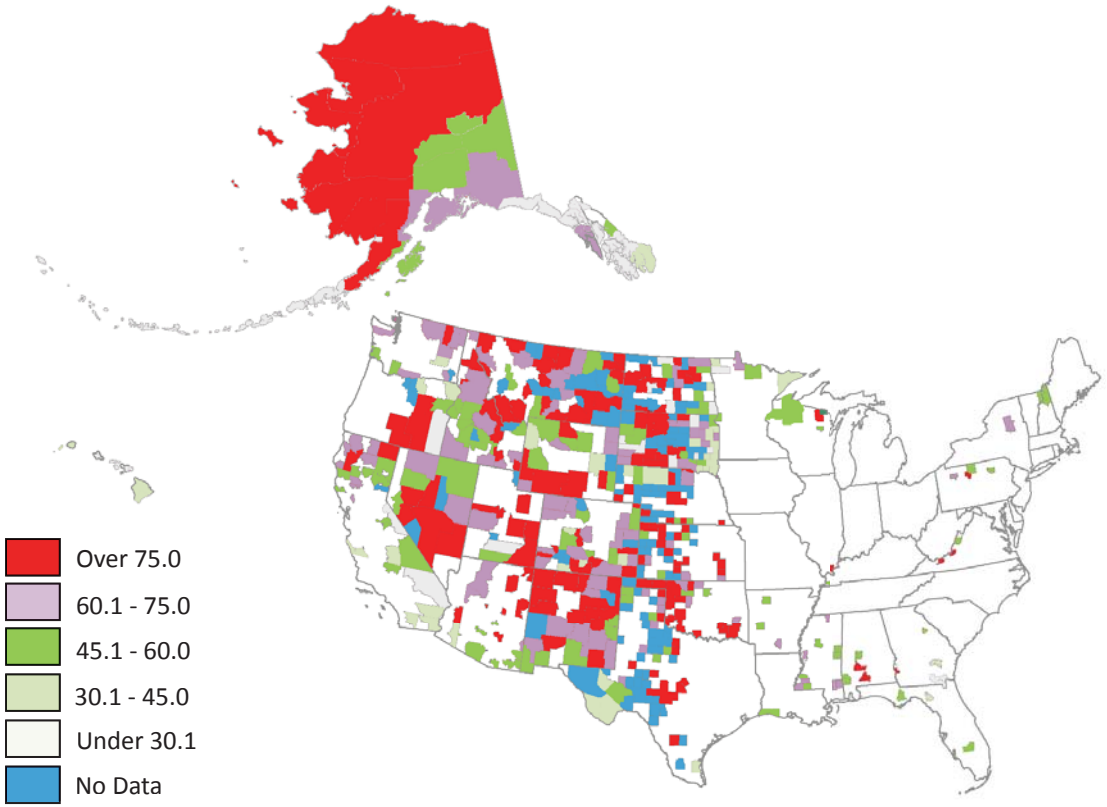


Figure 45: Unintentional Injury Mortality rates per 100,000 (Source: CARES, 2011). Injury mortalities are higher in frontier counties compared to other health conditions at a national level.

Figure 46: RURAL Abandon Building (Source: Staloch)

DESIGN GUIDELINES

1 **OPTIMIZE USER ACCESSIBILITY**

2 **OPERATE FACILITY OFF THE GRID**

3 **CONSTRUCT MODULAR UNITS**

4 **STANDARDIZE CLINICAL SPACES**

5 **CREATE ADAPTABLE SPACES**

6 **MAXIMIZE STAFF CONNECTIVITY**

To successfully accomplish the thesis objectives, a series of rural health design guidelines have been developed to demonstrate how to achieve the goals for a rural project. They respond to the literature review for rural processes and case study research that expresses rural strategies for design. Select guidelines apply to each of the objectives. Standardization, modularity, and adaptability all relate to the operational efficiency objective for sustaining rural medical services. Connective and accessible health areas meet the needs of the patients and promote quality care environments. Multiple guidelines support the goal for the building and operation processes to be cost efficient. Thesis guidelines include architectural concepts of accessibility, self-sufficient sustainability, modularity, standardization, adaptability, and connectivity.

Each guideline establishes design strategies to illustrate how to apply the guideline to the design project. They are developed from rural architectural precedents that address the problem presented from the context of accessing healthcare in rural regions.

Optimize accessibility

Rural facilities should be highly accessible to all patients at all scales of the project from determining site location to building design. Difficulties to healthcare access in the frontier include the distance between services, geographical barriers and the lack of transportation. Rural health centers should be inviting places for community members to use and provide access to people with any ability. Accessibility includes being centrally located to the populations they are intended to serve along major highways, being co-located with other businesses in the region and being highly visible civic places in their communities.

Rural healthcare clinics should be centrally located to the populations they serve to allow the maximum utilization and access to the site. Frontier areas typically have great distances between towns and the only connection amongst towns is often a two-lane primary road. Clinic locations along these critical transportation arteries optimize navigation for visitors to the facilities and access for patients, providers and suppliers. Frontier services usually receive supplies by truck and deliveries may only come a few times a year in some locations. Therefore, it is important to simplify access by locating on a main road that is regularly traveled and links the clinic to its service population, regional services and the world at large.

Isolated communities already face barriers to accessing goods and services specific to their community and healthcare should be just as accessible as other services offered to frontier communities (Scott et al., 2013, p. 165). Clinic locations should be co-located with other businesses in the region to optimize convenience for frontier people that make one trip to town to do several tasks.

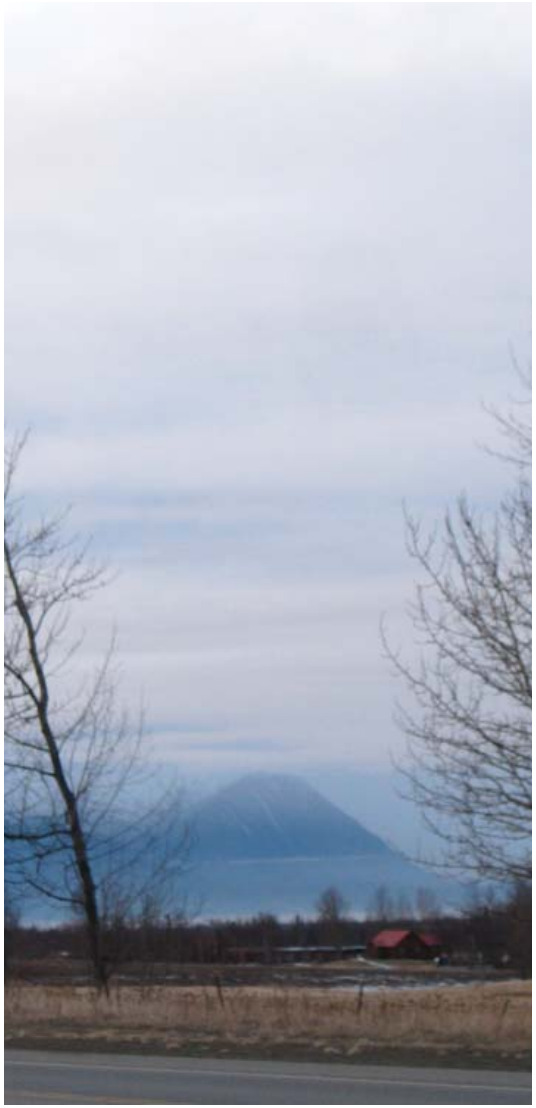


Figure 47: Isolated Communities (Source: Staloch)

Accessibility also involves being highly visible and providing usable public places within the facility for their communities. Minimal infrastructure in frontier areas demands that civic buildings such as healthcare settings also function for public gatherings. The facility should provide gathering spaces that allow community members, patients and staff to use for a variety of community events and activities. Public zones within a frontier health center should be accessible after business hours when clinical functions may be securely closed.

Centrally located to dispersed populations: Each site should be evaluated on the rural frontier definition of distance from a critical access hospital or other health facility, travel time to reach emergency care and the population density. Centrally locate a facility on a site that allows the most direct access to the greatest number of people dispersed within the target

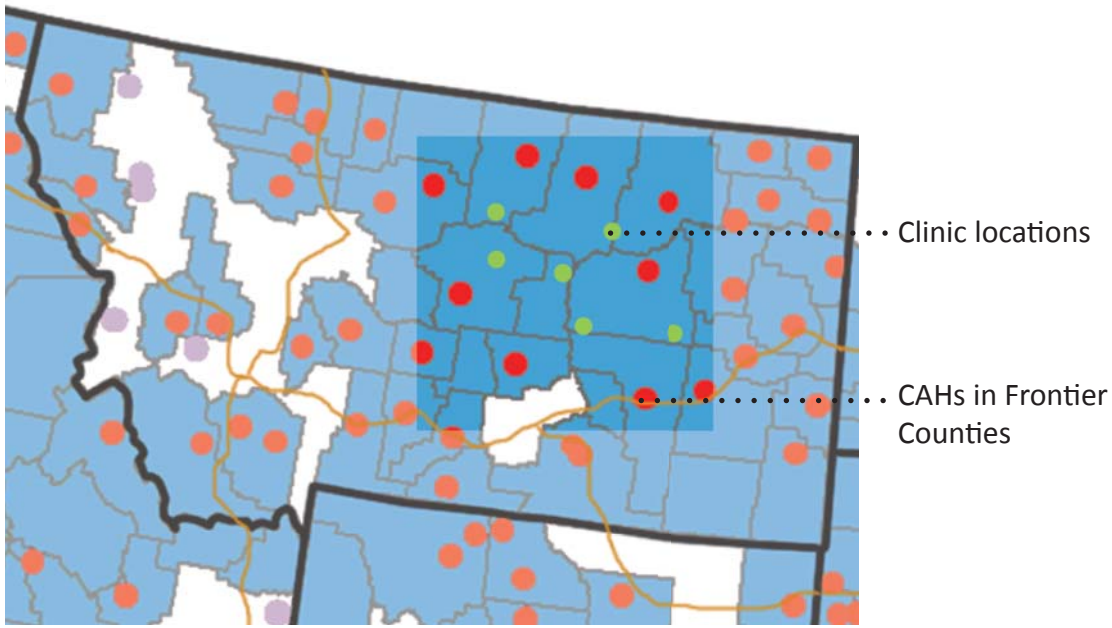


Figure 48: Site Selection and Coordination Diagram (Source: NCFC, 2014, Diagram by Staloch). Promote geographic access through site coordination with surrounding CAHs and health centers. Within the frontier counties in blue, rural clinics can strategically dispersed to allow uniform access and minimize redundancy.

service area of the healthcare facility. Site selection should be coordinated with other health service providers to optimize access to the greatest number of people and minimize duplication of services. Criteria for centralization include the distance to another health facility, demographics of the area and number of people residing in the region. CAHs are dispersed throughout vast rural regions and a clinic located between other medical centers minimizes duplication.

Located along major highways: Site selection includes being located along major highways that provide access to surrounding communities and towns in the region. Frontier areas may only have one major highway that connects regional development. Use this central transportation route to maintain connection with other frontier services. The frontier town of Glennallen, AK selected a site for health access on Highway 1 which is the only vital connection between the regional city of Palmer and the western Alaskan frontier. Palmer has the closest hospital which is 136 miles away. Their clinic location is convenient for users in the area that all use Highway 1 for their routine travels.

Vehicle and air transportation often provides critical access to healthcare in remote communities and may also dictate the location of rural medical centers. Surface transportation remains the most common and most frequent mode of transportation in frontier areas. In most places it is the only way to travel. The site of a rural clinic must be directly accessible from the main public road to allow users to drive to the health clinic. EMS will also use these arterial roads to access the site and respond to people in need around the region.

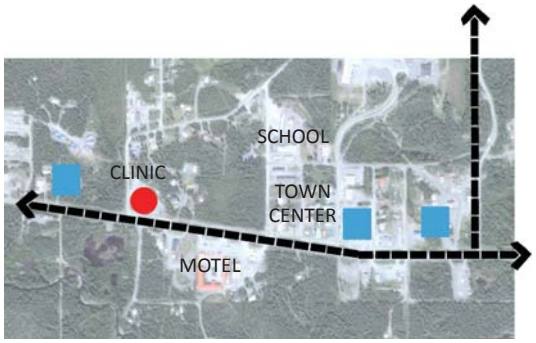


Figure 49: Frontier town connection with services (Source: Google Map, Diagramed by Staloch)

Figure 50: CrossRoads Medical Center in a Frontier Town (Staloch)

Figure 51: Pictou Landing Health Centre (Source: Richard Kroeker Design)

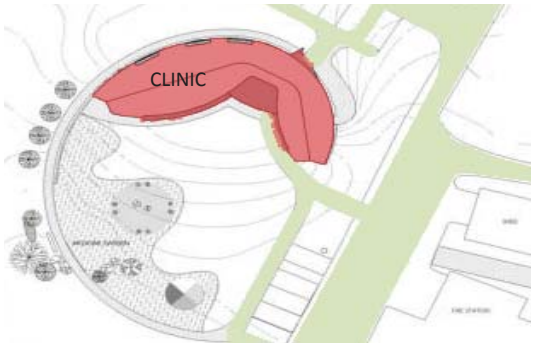


Figure 52: User Site Access for Small Community (Source: Richard Kroeker Design, Diagramed by Staloch)

Air travel is important for frontier health emergencies. Airlift costs out of frontier regions is a great expenditure to the Medicare program and frontier clinics that can stabilize patients for surface travel save Medicare costs (MacKinney, Mueller, Ullrich & Shell, 2012). If air travel is inevitable, locating a medical facility on a major highway also allows access for patient travel from the clinic to a local air landing site. In some cases, a major road may in fact even serve as a landing strip. Maintain access to a nearby airport, airstrip or helicopter landing area so that rotating staff can come and go by air and emergent patients can be transported out by air when necessary.

Pictou Landing Health Centre is located within a rural town on Highway 348 north of the regional town of New Glasgow, Nova Scotia. This is the major road through town and connects the rural area with the rest of the peninsula region. Personal vehicles and walking are the modes of transportation for the region and the healthcare site allows people to access the building through either mode. The walking paths around the site connect the sidewalks from the town to the entrance of Pictou Landing. Vehicle traffic is more common and accessible for users to drive to the site from the main highway and park in the clinic lot.

Co-located with other essential services in the community: Part of frontier life is making a single trip into town to accomplish multiple tasks. To optimize healthcare access, co-locate health services with public spaces and other essential community services such as the local school, post office, grocery store, gas station, café or church. The co-location of health clinics with public services allow for convenient access to other fundamental needs of daily frontier life. To optimize access, select the site near or central to other established businesses in the community.

At the scale of the project site or within the building, provide open public and community spaces can that can be used for various community events and activities including town meetings, educational activities, voting and other community events. Co-locate larger expanded hallways near meeting rooms for informal gatherings associated or not associated with larger, more formal, public gatherings. Locate and design rural health centers in a way that makes them a highly visible, accessible and an inviting civic place in the community. This can be achieved by gradual connections of public circulation and gathering spaces like the open space in the Ed Roberts Campus. The entrance runs into a gathering space that connects with a central, iconic circulation ramp. Materials and light distinguish the different spaces and the co-location of spaces allows users to access each part of the public area. Peace Island Medical Center connects adjacent public services including registration, waiting, a coffee shop and a historical gallery within one public circulation path.

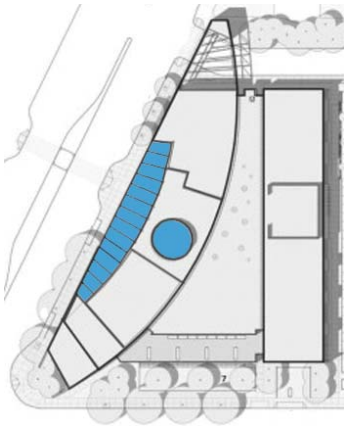


Figure 53: Public Space within Ed Roberts Campus (Source: Leddy Maytum Stacy Architects , Diagramed by Staloch)

Figure 54: Open Public Space (Source: Leddy Maytum Stacy Architects)

Operate self-sufficiently

Figure 55: Pictou Landing uses Sustainable Measures (Source: Richard Kroeker Design)

Being situated in remote areas, often subjected to unpredictable and severe weather conditions, and with limited connections to the outside world inherently requires buildings to be as self-sufficient as possible. This includes being both conservative in the use of energy and having reliable, independent and backup sources of energy. Self-sufficiently also includes sustaining and having access to locally available sources of water, healthy and safe waste disposal and other critical resources necessary for daily operations.

It is imperative to minimize energy use overall and function when necessary without reliance on any utility system. Operating a facility self-sufficiently also includes minimizing or eliminating carbon emissions, minimizing the dependence on fossil fuels and, whenever possible, meeting the energy needs of the facility as independently as possible. A combination of environmentally sustainable design strategies can enable the facility to address the health of the local community and globally within the natural environment.

Rural remote areas may not always have reliable energy systems due to extreme weather conditions, inadequate infrastructure and isolated connections. In addition, rural areas must account for the inherent transportation cost and inefficiencies of delivering fuel and services. Rural health clinics need to be able to maintain operations as independently as possible given their distance to resources and backup services. As an essential service, rural health centers should be able to continue providing healthcare to people in need at any time in remote areas without concern for a disruption of services. In addition to reflecting the independent frontier mentality of the populations they serve, being

relatively self-sufficient can have other advantages as well. Self-sufficiency involves producing “as much renewable energy as it uses, through a combination of energy conservation and renewable energy projects” (Guenther, & Vittori, 2013).

Minimizing the overall carbon and energy footprint of a facility involves reducing its total embodied energy. Results of carbon footprint assessment “indicate that while operational energy is more significant over the long term, the embodied energy of key materials should not be ignored, and is likely to be a bigger proportion of the total carbon in a low carbon building” (Alwan, & Jones, 2014, p. 49). The embodied energy in a building is the product of the energy and other resources required to extract raw materials, process them into building products, ship and assemble the component materials and assemblies of a building. The embodied energy for a building can be even higher in rural areas, so locally available building materials should be used whenever possible.

Figure 56: Kiowa County Memorial Hospital received LEED Platinum (Source: Archpaper)

Additionally to sustaining a facility, use alternative systems to decrease the amount of staff working in the facilities department. Low maintenance mechanical system design allows for minimal full-time-employees to operate the Peace Island building mechanical systems. Only one full time employee works in the facility department and can adjust the systems as necessary from remote locations.

This guideline applies to multiple levels of consideration within the building and incorporates a variety of sustainable features to impact the overall self-sufficiency. Total levels of sustainability allowed Kiowa County Memorial Hospital to be the first CAH to receive a LEED (Leadership in Energy & Environmental

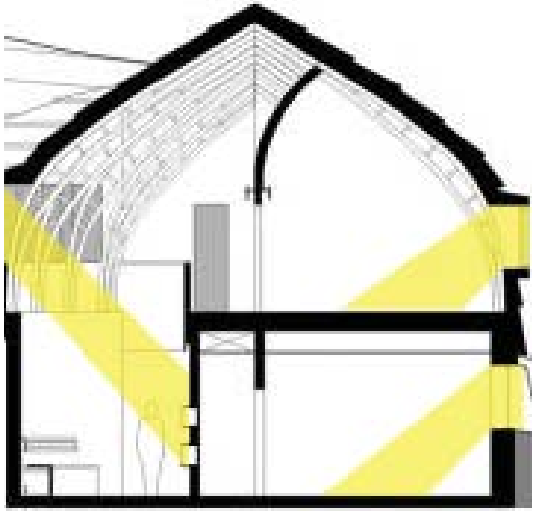


Figure 57: Section of Distilled Sunlight (Source: Richard Kroeker Design, Diagrammed by Staloch)

Figure 58: Pictou Landing Distilled Sunlight (Source: Richard Kroeker Design)

Design) Platinum certification and it serves as an example of how rural medical facilities can operate effectively while employing a variety of environmental features.

The rural hospital operates with minimal impact on the environment utilizing systems such as a wind turbine, natural light, water conservation and a heat recovery system to offset the energy demands (Guenter et al., 2013 & Greensburg GreenTown, 2009). The wind turbine produces enough energy to offset the energy that is used within the building. Natural light brought into the medical facility reduces the energy that would have been used to light the space. Water is conserved on this site by being collected, treated and stored for reuse to reduce the amount of water utilized within the building. Minimizing the total energy that is used to operate the building in rural areas optimizes self-sufficiency in a frontier location.

In order to optimize self-sufficiency and sustainability, rural clinics should be designed to consider orientation, passive ventilation strategies and shading that provide passive approaches to tempering the indoor environment. The orientation of the building influences solar gain for the building; therefore consider the rural climate and physical conditions of the local region. Orient the site plan so that building elements are organized with the long axis East-west to distill sunlight in the morning and afternoon. However, building facades also need to have controlled systems based on their orientation to filter in the amount of light as necessary for the climate. Position small clinics on the site to direct natural ventilation through the building. Record wind patterns and develop proper ventilation areas according to these patterns to allow air to move through the building. Natural air flow through the building

minimizes the thermal conditioning needed and therefore can reduce total energy used for operations. Use design features to properly shade and limit unwanted heat gain and glare from intense sunlight. Sun and daylight control features could include interior shading devices or exterior façade systems.

The design of the building facade should allow for additional energy savings. A tight building envelope maintains environmental efficiency (Soloman, 2003). Increase the insulation within the building envelope to minimize the use of mechanical conditioning systems. Designing a thick, insulated envelope provides great thermal efficiency especially in cool temperate climates (Hearth, 2014). The Fort Providence Prototype modeled façade walls to be about 300mm thick with two layers of insulation. Total insulation value of the exterior walls is 4.83 RSI (metric) which is equivalent to a 27.43 R value. The wall space maximizes the amount of insulation within the façade to keep the building air tight.

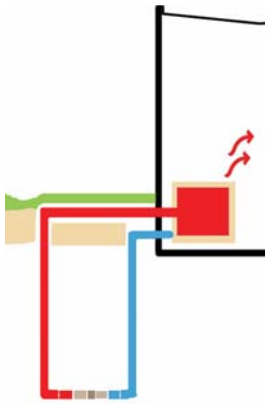


Figure 59: Geothermal Diagram (Staloch)

Design mechanical systems to conserve energy use within the building through solar hot water generators, ground source heat pumps or small-scale hydroelectricity (Rechal et al., 2009). Collect solar heat through a thermal system to heat water used within the building and decrease the demands on a mechanical hot water heater. Ground source heat pumps used on a rural site increases the efficiency of heating and cooling systems. The appropriate design of lighting and thermal controls allows users to regulate these systems.

Figure 60: Patrick H. Dollard Health Center (Source: Guenther 5 Architects)

Energy independence and back up: Incorporate alternative systems to provide redundant and back up energy sources for rural clinics. In rural areas, design for sustainable energy systems by utilizing local

Figure 61: Roof view of solar panels at Martha's Vineyard CAH (Source: Google Maps)

Figure 62: Solar Panels at Martha's Vineyard CAH in Oak Bluffs, MA (Source: TMPartners)

resources including ground heat, wind, sun and wood.

South facing solar panels on the CAH in Martha's Vineyard generate alternate, independent energy to operate the facility. Place panels on the south sloping roof surfaces to optimize the amount of collected energy and allow the system to distribute energy to suffice the operations within the building.

Geo-thermal heat pumps can reduce the heating and cooling demand on the building. The Patrick H. Dollard Health Center is 28,300 square feet and uses geothermal ground source heat pumps to heat the entire building. Peace Island Medical Center also generates usable energy though intentionally constructing the building with a geothermal energy system. Through twenty-two vertical wells, heat (or cool air in summer) is pulled up out of the ground and distributed throughout the facility (Schierhorn, 2015). Pictou Landing Mi'Kmaq Community Health Centre also uses ground source heat pumps for geothermal heat during the many cold months of the year in Nova Scotia. Additionally, the building contains a thermal mass built into the ground which regulates the heat and cooling system. The Health Centre has "shown to operate with 43 percent less energy input than a conventional building of the same size" (Guenther, 2013). Geothermal applications allow the rural medical facilities to self-sufficiently heat and cool the building.

Whenever possible, Design a wind collection system to supplement energy in rural buildings. A wind generator on site at Kiowa County Memorial Hospital offsets 40% of the building's energy use (Guenther, 2013, p. 140). The wind turbine "generates approximately 220,000 kWh annually to reduce the grid power needed to operate the hospital" (Greensburg GreenTown, 2009). The rest of the grid power is supplied through a wind farm south of town.

Figure 63: Kiowa County Memorial Hospital Wind Energy (Source: Health Facilities Group)

Some rural health centers can optimize energy independence by using features such as a wood pellet burning stoves or by collecting and burning methane gas when they are appropriate for the project region. Captured methane gas from landfills and composts reduce the negative impacts to the atmosphere by converting the gas into usable energy (EPA, 2014). Bakerview EcoDairy is a rural farm that collects manure from their farm and dispenses it to an anaerobic digester to convert methane from waste into electricity to operate the farm buildings (Sanborn, 2013). Rural facilities located near viable sources could use methane from composts at nearby agricultural operations. Another local resource strategy utilizes wood in the form of pellets which is a more efficient fuel than conventional firewood for furnaces and stoves. Frontier counties that have temperate climates and are located in heavily forested regions can use large stoves to burn wood pellets for heat. This system is more commonly used in cold areas such as Canada and Alaska.

Figure 64: Wood Pellet Storage in Fort Providence, CA (Staloch)

Natural resource independence: Rural facilities can operate self-sufficiently through stewardship of other natural resources. Water, for example, can be conserved, collected, stored and then reused.

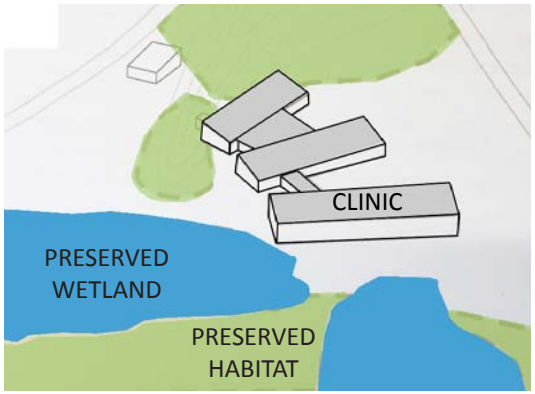


Figure 65: Environmental Diagram of Peace Island Medical Center (Source: Mahlum Architects, Diagrammed by Staloch)

Figure 66: Peace Island Medical Center Preserved Habitat (Designed by Mahlum Architects, Source: Staloch)

Figure 67: Environmental Diagram of CAH Prototype (Source: BBH Design, Diagrammed by Staloch)

Figure 68: CAH Prototype (Source: BBH Design)

Collect water and treat it on site whenever possible. Design the site and roof water to collect and store the surplus water for future irrigation needs. Peace Island Medical Center collects water on site and then filters the water through designated rain gardens similar to the recommendations from the CAH Prototype project for the DHHS in partnership with BBH Design (PIMC, 2014 & Guenther, 2013). Storm water retention and re-use should be routinely employed in rural health centers. Nanaimo Regional General Hospital Emergency Department collects storm water and retains the water in tanks below centralized courtyards for future use to irrigate the courtyards and other landscaping on site (Guenther, 2013). Rainwater is collected at Kiowa County Memorial Hospital and used for toilet flushing to conserve additional water. Excess potable water is distributed to irrigate some landscape features and stored in an open pond. These features reduced potable

water use by 57% over the building code (Guenther, 2013, p. 140).

Daylight distribution: Frontier buildings that strive to be self-sufficient can reduce their total energy needed to operate the building by employing daylight whenever possible. Bring light into interior spaces with high ceiling designs and clerestory windows that filter natural light into central spaces. Adapt the design to the regional sun patterns to allow filtered and controlled daylight into as many patient care and staff work spaces as possible. Legacy ER distills light from skylights to allow light in staff and patient areas. The roof angles allow for light to filter into intentional spaces.

Interior design decisions that minimize energy can also add up to make a difference in the total energy savings. Small elements such as LED light fixtures increase energy savings. Reducing incrementally small amounts of energy across a wide variety of systems generates a smaller total demand for energy and makes sustainable sources even more viable for self-sufficiency. Maintaining habits like regulating the thermostat and turning off the lights in unused areas “make enormous differences in energy consumption” (Eagle, 2014). A series of small actions can add up to significant impact over the whole building.

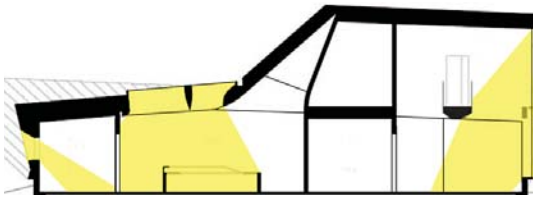


Figure 69: Distilled Sunlight Diagram (Source: 5G Studio, Diagramed by Staloch)

Figure 70: Legacy ER Distilled Sunlight (Source: 5G Studio)

Employ modular construction

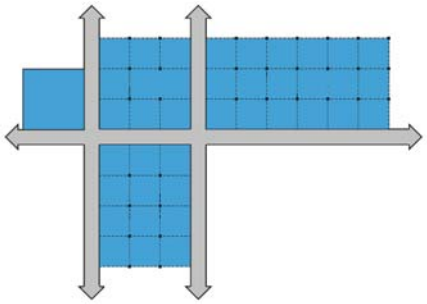


Figure 71: Modular Structure Pattern in the CAH Prototype (Source: BBH Design, Diagrammed by Staloch)

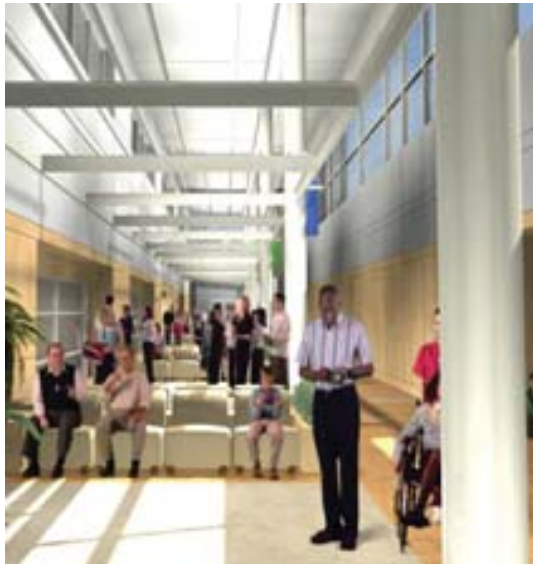


Figure 72: Interior Structure of CAH Prototype (Source: BBH Design)

Rural health must be able to respond to unreliable futures and the need for consistency at the same time. Changing models of care along with new telehealth measures and provider shortages add to the need to accommodate change in rural health clinics. In the current uncertainty for the future of rural health operations, the building layout, circulation patterns and space planning must accommodate the possibilities of change. Use a uniform modular space system to regulate similar components. This system will allow for additive and subtractive modular design throughout the building and can better accommodate changing needs over time.

Modular design strategies require a more disciplined and coordinated approach toward the design of structure grid patterns and clinical planning. The structure must be designed to support the uniform placement of modular units designated as exam rooms, offices or other specialty areas within core structural and infrastructural systems.

Limiting factors of the frontier community include minimal access to skilled labor associated with building to the standards of healthcare occupancies. Additional constraints for rural construction include the added cost of transportation for labor and construction materials. A growing trend toward modular construction of healthcare facilities can respond to changes in clinical practice, patient demographics, and funding mechanisms (Carthey, 2011). Modular construction involves the assembly of prefabricated units for building on site. Building with modules requires intentional planning of all spaces and benefits from minimal wasted resources.

Independent modules, such as prefabricated exam rooms, can be repurposed to other spaces such as offices or supply spaces. This enables rural clinics to accommodate changes in need over the lifecycle of the health facility. Construct independent modular units that include electric and medical utilities designed to facilitate future maintenance. A modular unit with its own utility components can be shut down independently for upgrades without interrupting other part of the facility. Adjustments to the modular unit can be made with minimal disturbance to other areas of the building that are in full operation (U. S. Department of HHS, 2005). Rural clinics with limited spaces should be able to continue services in one unit while another is shut down. Modular construction can minimize disruptions to operations during construction by creating independent utility connections within each unit and replacing individual modular units as necessary without impacting construction to other units.

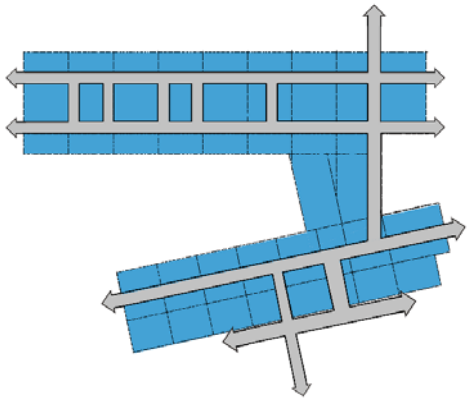


Figure 73: Structure Pattern of Peace Island Medical Center (Source: Mahlum Architects, Diagrammed by Staloch)

Pattern a grid structure system: Design the building structure in a grid pattern so that it can incorporate modular units for exam rooms or other medical spaces. Layout grid patterns to be regularly spaced and rectangular for the organization of a small footprint building. These symmetrical patterns should be configured to support the layout of clinical spaces. The CAH prototype and Peace Island Medical Center each employ a structural grid pattern to incorporate planned modular units for patient areas. They use structure to set modular placement and programming. Each corridor borders the structural grid as a means of arranging modular exam units along the circulation paths.

Figure 74: Exterior pattern at Peace Island Medical Center (Designed by Mahlum Architects, Source: Staloch)

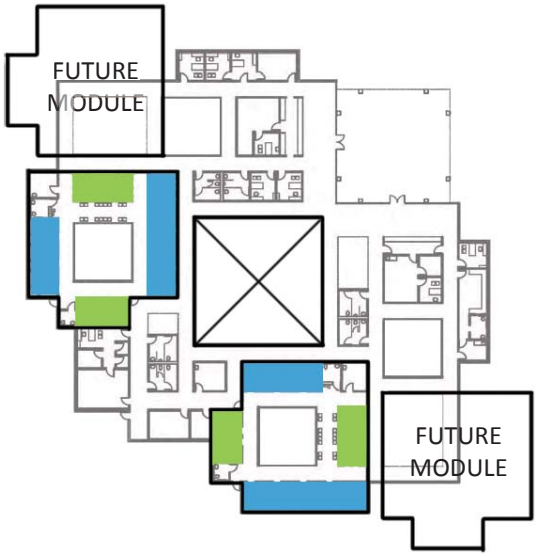


Figure 75: Modular units and future expansion plan (Source: Philip Patrick Sun, Diagrammed by Staloch)

Figure 76: Modular design for Delta Health in Mound Bayou, MS (Source: Philip Patrick Sun)

The outpatient pods at Peace Island Medical Center are designed as clinical units to form modular layouts and accommodate future expansion. The grid pattern layout allows for future connection to the existing structure system and possible expansion of one side of the building.

Utilize prefabricated construction: Design prefabricated modular units to improve the quality of construction and optimize construction processes on rural projects. Plan modular pods with comprehensive information of the project framework including structural grid pattern, overall building size and floor plan arrangements. Planning within a systematic building framework eliminates errors in construction.

Delta health clinic was designed to employ prefabricated rooms or units of several rooms linked by corridors and infrastructure that was constructed on site. The building construction set modular dimensions for the framework to be built as a core structure. Each of the building frames was conceived to accommodate prefabricated patient exam and office units. The dimensions and rooms were replicated throughout the facility in two pods and for two additional pods in the future. The modular pods were designed to be duplicated throughout the site by employing open ended corridors.

Design modules to fit within the confines of transportation and shipment restraints. Prefabricated units are limited to the restrictions of a semi-truck and/or ferry boat depending on the frontier area.

Modular elements for prefabrication typically include exam rooms, toilet rooms and wall units. The modular construction of these utility intensive spaces accelerates the construction process and allows all the units to have the same construction quality. Miami Valley Hospital was designed to incorporate prefabricated headwall and toilet units and built the units in a warehouse offsite. All the units were placed efficiently and sped up the construction process. Prefabricated headwalls and bathrooms in the Mercy Hospital Joplin project contributed to the faster speed of construction to optimize recovery from a tornado four year prior (Ferenc, 2015).

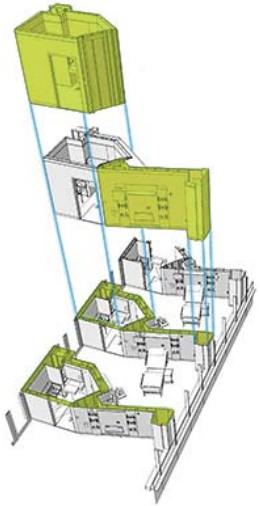


Figure 77: Prefabricated headwalls and toilet rooms (Source: NBBJ, Diagrammed by Staloch)

Figure 78: Prefabricated units for Miami Valley Hospital (Source: NBBJ)

Standardize clinical spaces

Figure 79: Standard rooms at Ely-Bloomenson Hospital (Source: Staloch)

The infrequent use of clinical spaces in rural facilities and the limited number of providers potentially working at multiple sites initiate the need for standardized clinical spaces. Set configurations and dimensions for clinical spaces allow transitional providers to work in uniform and familiar work environments that are replicated across several facilities they may rotate between. Standardization includes organizing clinical layouts for standardized care delivery.

Rural healthcare facilities must be designed to accommodate significant fluctuations in staff, workloads, and care processes. Use standardization to overcome these operational struggles and create a flexible work environment. Pati states that “physical design plays a crucial role in facilitating or impeding organizational and personnel ability to changing workload demands, staffing patterns, and operational challenges” (Pati et al., 2008, p. 227). Rural healthcare facilities must create a working space that is suitable for their challenges and continuing operations.

Design emphasizes that “standardization is the key to flexibility” and it is even more applicable to rural facilities (Robeznieks, 2013). Use the flexibility of standardization to accommodate several different functions within the same space such as offices sized to be easily converted to exam rooms or support space. Standardized modules can also be “subdivided when the need arises, resulting in spaces that are ‘fit for purpose’ for a specific function while also allowing the space to morph to suit different activities and service conditions” (Carthey, 2011). Exam rooms that are fit for primary care can support over flow urgent care needs. Creating spaces with typical, consistent dimensions and configurations enable a clinic to quickly adapt to particular needs as change occurs.

Standardization applies to macro-scale building features such as structural systems and also to smaller scale items within clinical areas. Structural systems must be designed on a standard unit to allow for future department changes. The standard unit criterion comes from the size of the building which is impacted by the overall structural layout and grid pattern.

The most common and critical applications of standardization is in clinical areas. Within clinical exam areas the standard layout, materials, and equipment must allow rural providers to use spaces for both clinical procedures and telehealth consults. Establish patient procedure room dimensions, configurations and equipment to accommodate a range of treatment modalities and procedures within frontier clinics. Room dimensions for Delta health pods were 10’ x 12’ for all patient exam rooms and offices. This set dimension is fixed to fit the space modules. This also accommodates future flexibility of the space to fit another purpose.

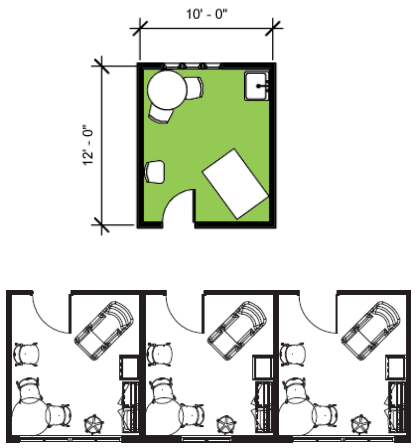


Figure 80: Standard Clinical Spaces at Delta Health (Source: Philip Patrick Sun, Diagrammed by Staloch)

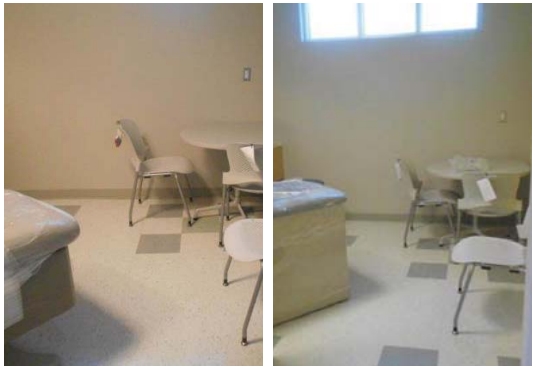


Figure 81: Standard Clinical Rooms at Delta Health (Source: Philip Patrick Sun)

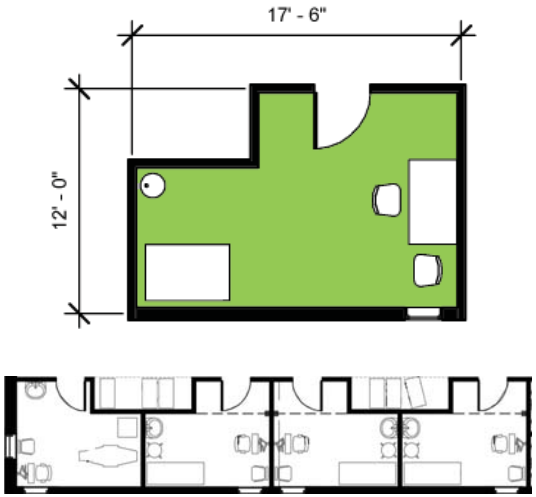


Figure 82: Standard Clinical Spaces at Fort Providence Medical Centre (Source: Stantec, Diagrammed by Staloch)

Figure 83: Standard Clinical Rooms at Fort Providence Medical Centre (Designed by Stantec, Source: Staloch)

Standardize clinical layouts: The limited number of working health providers in medically underserved areas influence the need for standard design in clinical layouts. Design standard clinical layouts as a prototype for visiting providers to allow seamless care across a variety of locations. Providers can work in spaces identical to those in other prototype clinics within their rotational service region. Fort Providence Medical Centre uses this concept as clinicians rotate within the health system. Each clinician provides seamless care with their familiarity of the organization of the facility and their work area. Each facility organizes the patient and provider exam areas with standard dimensions and furnishings. The exam rooms have identical casework in all the same locations and similar finishes applied to the space. The primary care rooms also have equipment that is the same across all rooms.

Plan universal room modules: To standardize flexibility for the project, design universal room modules to accommodate a variety of uses. Infrequently used spaces in rural health clinics and the low volume of patients minimize utilization for special purpose rooms. Therefore, plan for multiple functions within one space to optimize the use of a fewer number of rooms in a smaller facility. To accomplish universal rooms, create spaces with standard dimensions and supply storage for a variety of uses such as telehealth, primary care, dialysis or a traveling specialist. Universal exam rooms in rural clinics should be sized for patient conversions, telehealth consultation, staff offices and storage spaces. Universal rooms within identical pods at Delta Health create flexibility for the rooms to be offices or exam rooms depending on the need. Each room is the same size and the furniture changes as the use of the rooms changes.

Figure 84: Universal Room Layout at Delta Health (Source: Philip Patrick Sun, Diagrammed by Staloch)

Figure 85: Universal Room at Delta Health (Source: Philip Patrick Sun)

Create adaptable spaces

Figure 86: Adaptable Room (Source: Staloch)

Clinic design must be flexible for the changing regulations, services and patient volumes that fluctuate within the context of rural health. The limited number of rooms in a small clinic footprint must adapt to a variety of functions to serve changing community needs. Adaptability is “the ability of a building (or space) to meet shifting demands without physical changes” (Olsson, 2010).

Rural clinics need flexible spaces to retain all the changing needs and uncertainties for the future. From an operational point of view “adaptability is the most desired form of flexibility” (Harvey, 2008, p. 34). Flexibility for multiple functions to use one space is “the ability to adapt the environment to new circumstances without making any change in the environment itself” (Pati et al., 2008, p. 215). Use adaptability in rural medical buildings by accommodating multiple functions in one environment such as a conference room doubling as a health education room or a telehealth exam room doubling as rehabilitation space. In order to be adaptable, spaces must accommodate “multiple uses or can be quickly and inexpensively adapted simply by changing the room name and furniture” (Hamilton, 2011, p. 111). Create an adaptable environment that allows each new function to successfully utilize the space.

Pati suggests that the adaptability of healthcare areas effect the “changes in the physical environment to adapt to a changing workplace practice” (Pati et al, 2008, p. 213). The specific context of rural clinic work processes influence the design for flexibility of the space. Therefore, rural clinics must adapt their environments to serve the ever-changing needs of healthcare, especially for staff, throughout the life of the facility.

Adaptability applies to any space or component that can change to better suit a new intention over the given circumstances. Public zones in rural health centers can evolve to serve a variety of assemblies. In community service buildings like a clinic, large spaces must accommodate public gatherings at various sizes from small group meetings to larger public gatherings. Create transitional public spaces within the building that form circulation to patient areas and double as reception areas for public spaces.

Use adaptable design in treatment areas to account for the fluctuating volume of patients that could use the facility. Design the daily use of medical spaces to alter hourly or seasonally and meet the varying needs of patient care. During seasonal or daily population surges, adaptable exam rooms should be designed for alternative uses such as triage or urgent care treatment rooms.

Plan rooms with multiple purposes: Plan one room to accommodate set multiple functions. Design components for each adaptable room should include storage space for furniture appropriate for the various uses within proximity to these areas to allow for easy transitions between functions. Design large conference rooms to flex into educational classrooms or community wellness spaces. The public space at Pictou Landing is wide to accommodate public circulation and doubles as multi-level reception space.

Figure 87: Public space to accommodate multiple functions at Pictou Landing (Source: Richard Kroeker Design)

A universal exam room design allows clinicians to provide of healthcare services in one room. The room should be at least 10’ x 12’ to accommodate care space and storage of equipment. Provide adequate room for a clinician zone and the patient zone. Fort Providence Prototype designed for a single multiple purpose screening room for all imaging and small procedures. The room contains a mobile x-ray unit and radiolucent stretcher and the intentional purposes for the room include telespeech, telerehab, observation, holding, general exam and dialysis. It is 12’ x 12’ to account to the extra equipment in the space.

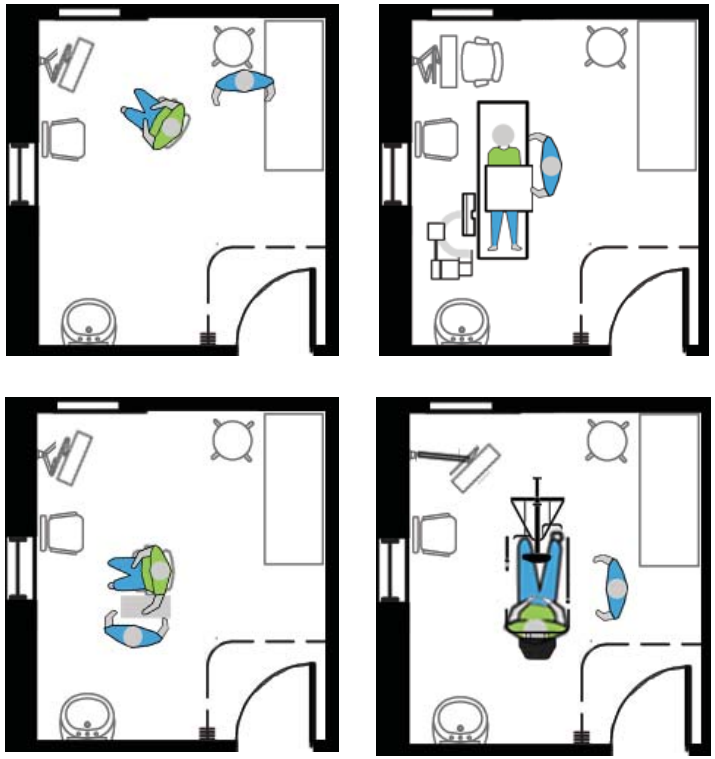


Figure 88: Multiple Purpose Screening Room at Fort Providence Medical Centre (Source: Stantec and PSAV Architects, Diagrammed by Staloch)

Accommodate changing needs over the given circumstances & the life of the facility: It is necessary to accommodate minimal impact changes without disturbing patient care. Design features should plan adaptable rooms for additional services and furniture alterations to accommodate the changing needs of the facility. Rural clinics need to plan for some work shifts with a minimal number of health providers utilizing the care area and need close proximity to support resources. At the same time, the spaces should also be able to expand for additional providers and patients. The design should accommodate exam rooms and offices to convert into emergency treatment and consultation space. Additionally add adjacent "soft" areas to be easily altered to provide additional spaces as needed within the private clinical areas. Ely-Bloomenson planned for additional soft space for telehealth rooms and adapted their use over time to also accommodate exams and traveling provider office space.

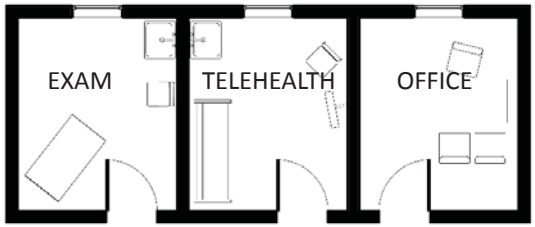


Figure 89: Adaptable Rooms at Ely-Bloomenson CAH (Source: DSGW Architects, Diagrammed by Staloch)

Figure 90: Adaptable Telehealth Room at Ely-Bloomenson CAH (Designed by DSGW Architects, Source: Staloch)

Peace Island Medical Center allows for the outpatient pods to accommodate offices, exams and procedure rooms to reorganize as necessary within the same setting. The pods are designed with simple geometrics and close adjacencies to each other.

To promote flexibility and accommodate uncertain changes as an FQHC, Delta Health utilized a furniture system in the patient exam rooms. The system adapts between rooms and accommodates the primary care needs for the clinic.

Staff support areas also must adapt over time to changing healthcare. Staff work spaces must be designed for various healthcare tasks. Locate “soft” spaces near staff zones to accommodate futures change.

Figure 91: Organization of Rooms for a Clinical Purpose (Source: Mahlum Architects, Diagrammed by Staloch)

Figure 92: Organization of Rooms for a Offices (Source: Mahlum Architects, Diagrammed by Staloch)

Figure 93: Furniture System Used at Delta Health (Source: HermanMiller)

Maximize staff connectivity

It is especially important in rural health centers to make sure that staff are connected to, and aware of, patients, visitors and peers at all times. Staff connections to people allows for efficient care, security and control of the clinic. These small facilities are often run with minimal staff who may need to move easily between greeting people as they arrive, providing patient care and coordinating with each other. Design features must be built to link staff to patients, visitors and peers with open visual connections within the built environment to allow collaboration. Design features include the design of partitions and circulation patterns around a central work area. Join two or more areas together to connect staff work space and create easy transitions for clinicians who may need to work across both primary care and emergency care spaces. In addition, incorporate staff accommodations with provisions for clinician housing. Maximize the opportunities for connection to promote security, access, and efficiency.

Working with minimal staff pattern requires rural health centers to optimize efficient operations. Connect staff work environments with care areas to increase operational efficiency and effectiveness that is needed to maintain business viability. Creating a cohesive environment leads to optimizing staff satisfaction and higher quality care delivery. Staff members work long hours for an extended period in clinical settings. Therefore, clinician work environments must promote health and satisfaction to encourage staff retention in rural health clinics. Healthcare reports claim that direct visibility of peers "enhances the perception of operational flexibility and efficiency and provides a sense of security for care givers" (Harvey & Pati, 2008, p. 30). Provide direct visual links within clinician work areas by incorporating open clinical pods. Within the clinical work zones, eliminate any unnecessary distance to further enhance processes for staff efficiency through closing the gaps for staff disconnect.

Figure 94: Connect Clinical Work Area with Entrance at Cook Hospital (Designed by DSGW Architects, Source: Staloch)

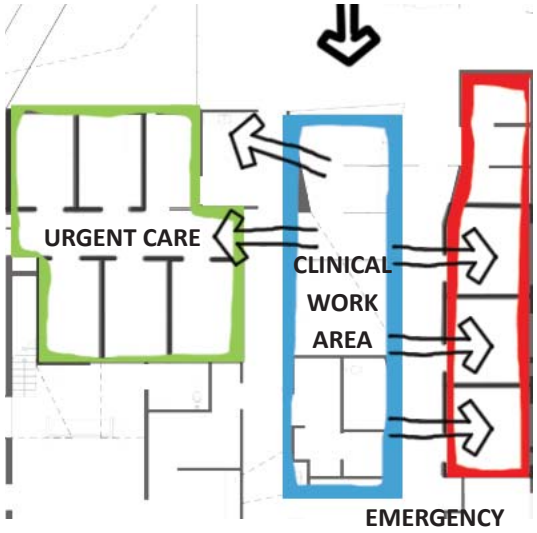


Figure 95: Central Work Area around Different Units (Source: 5G Studio, Diagrammed by Staloch)

Figure 96: Central Work Area in Legacy ER (Source: 5G Studio, Diagrammed by Staloch)

Security is especially important with low staffing in rural clinics. Staff members are the first line of contact for any entries and their central position should accommodate necessary secure measures. Staff must be aware of individuals entering and exiting the building while continuing to provide patient care.

Maximize staff connectivity within central work areas, circulation paths and through telehealth measures. The central work areas must be adjacent to entrances, primary and emergency care units. Plan circulation paths to link private staff areas to semi-private health treatment areas.

Within clinician areas, connect people and spaces through planned openings and partitions such as doorway placements and half walls. Wall partitions either promote or limit connection and in rural clinics they should all be designed to accommodate each intentional purpose. Partitions within clinical zones must allow transparency for staff views to patient areas. Incorporate transparent materials for partitions to create separation for privacy while encouraging visual connection to others.

Centralize work spaces: Centralize staff work zones to optimize possible moments of visual and perceived connections. Central work areas for multiple patient units minimize the amount of staff members and support spaces needed to operate the entire facility. Design shared staff work areas with simple circulation around the work areas and visual connection to patients, peers and visitors. Legacy ER uses a central staff area with connection to urgent care on one side and emergency care on the other side. The clinical area also links to registration and allows staff to meet patients at the first point of contact.

Fort Providence Medical Centre designed clinical circulation that connects staff work areas with adjacent clinical space. It includes a central core support area with connection to the clinician zone without interruption from public circulation. Ely-Bloomenson Hospital central staff area is all connected except for offices for the director of nursing. In the work area, core support spaces keep visual and physical connection between staff. This central area shares support spaces and minimizes redundancy.

Figure 97: Fort Providence circulation node during construction (Designed by Stantec & PSAV Architects, Source: Staloch)

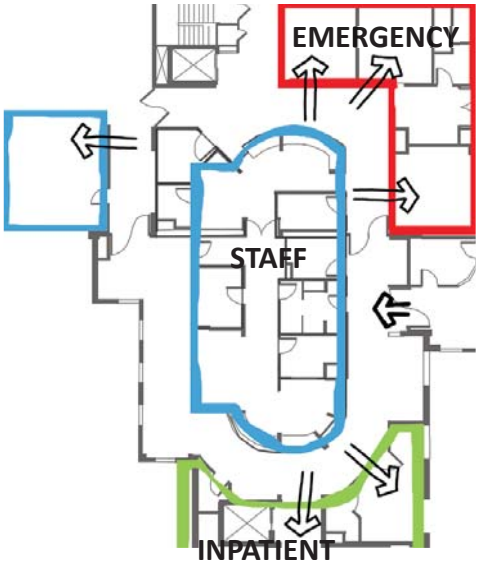


Figure 98: Central Work Area around Different Patient Units (Source: DSGW Architects, Diagrammed by Staloch)

Figure 99: Clinical Circulation inside the Work Area at Ely-Bloomenson CAH (Designed by DSGW Architects Source: Staloch)

Optimize open clinical pods: When appropriate, design an open clinical pod to visually connect staff with others working in the environment and patients seeking treatment. The exposed space should be designed to enhance care team coordination and visually allow staff to see peers who may need assistance with a patient while maintaining patient privacy as needed.

Design features for the exposed environment should integrate natural daylight into the clinical work space. Place high ceilings and clerestory windows to distill natural light inside. This encourages staff wellbeing and creates a positive environment. The open work area at Hicks Orthodontic allows for the maximum amount of daylight to enter the space and clear sight lines within the work area. Design features used to accomplish this include an open floor plan, a curtain wall façade, and high ceilings.

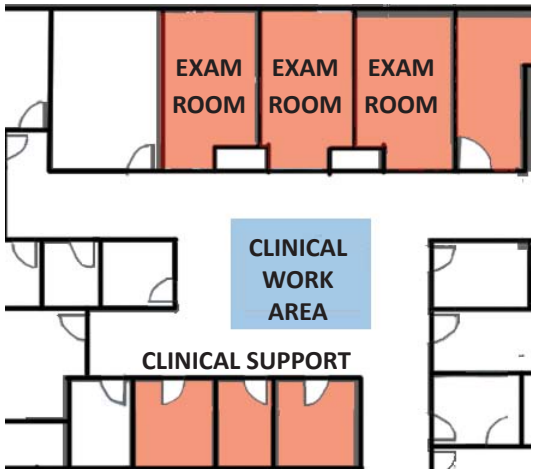


Figure 100: Central Open Clinical Area (Source: HGA Architects, Diagrammed by Staloch)

Figure 101: Open Clinical Area at Reeves County CAH (Source: HGA Architects)

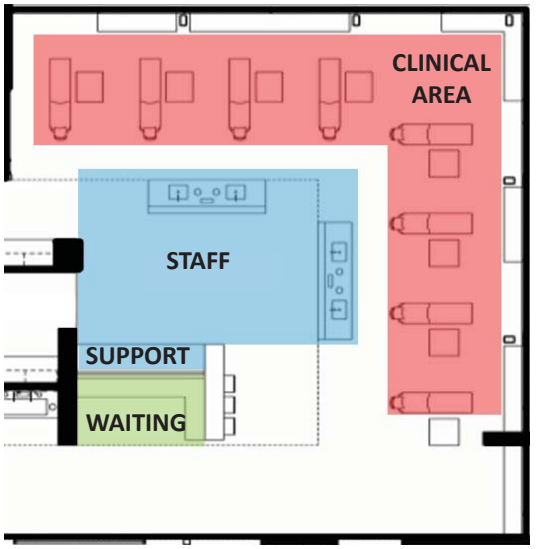


Figure 102: Open Clinical Area (Source: BarberMcMurry Architects, Diagrammed by Staloch)

Figure 103: Open Clinical Area at Hicks Orthodontic (Source: BarberMcMurry Architects)

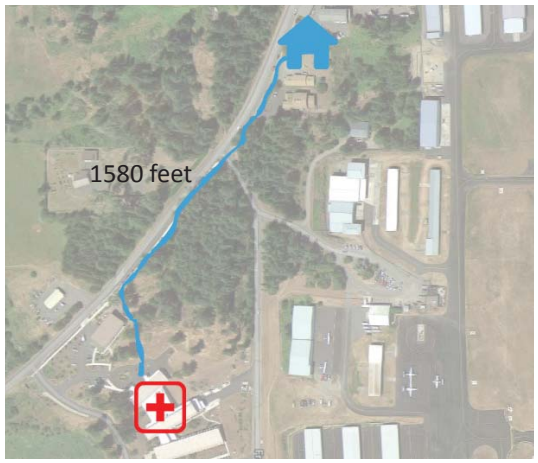


Figure 104: Map of Provider Housing in Friday Harbor, WA to Peace Island Medical Center (Source: Google Maps, Diagrammed by Staloch)

Figure 105: Peace Island Medical Center Provider Housing in Friday Harbor, WA (Source, Staloch)

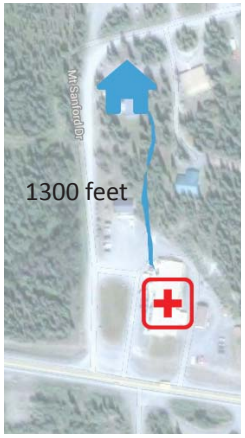


Figure 106: Map of Provider Housing in Glennallen, AK to CrossRoads Medical Center (Source: Google Maps, Diagrammed by Staloch) & Photography of the Provider Housing (Source, Staloch)

Figure 107: Fort Providence Medical Centre Provider Housing in Fort Providence, CA (Source, Staloch)

Provide housing for clinicians: To overcome the largest barrier to accessible healthcare in rural areas, some providers must be able to circulate between multiple clinics in frontier regions. They require temporary or transitional housing accommodations. Maximize their connection by providing housing near the medical center. Temporary housing eliminates commuting time and expenses for providers who may not live permanently in the community. Clinician housing could be in a separate building or attached apartment. Connecting the staff through housing allows clinicians to work for extended periods and then return home after their routine shift is finished. Peace Island Medical Center and Crossroads Medical Center promote staff housing by minimizing the distance between the medical facility and the allotted staff housing. They each incorporated a designated walking path between housing and the facility.

Figure 108: RURAL South Dakota (Source, Martel)

SPACE PROGRAM

Research, case studies and site visits informed the development of a model rural clinic space program. The literature review of best practices for ambulatory healthcare settings, particularly rural healthcare settings and interviews with designers and medical staff at visited observations sites added valuable insights in developing program components. Staffing and operational models greatly impact the delivery of care at rural facilities and inherently demand variation at some level for every clinic in every context. Variations to the spaces depend on the demographic needs in the region, ownership of the clinic, attachment to a local health system, type of clinicians and services offered. New policy changes and new care models such as the Frontier Extended Stay Clinic (FESC) demonstration project influenced the final program for a clinical building. Spaces must be accessible, pursue high quality healthcare delivery, be operationally sustainable, and be culturally relevant.

The building program developed in this thesis can be viewed as a kit of parts that can be employed more or less comprehensively depending on the particular needs of a particular community. It includes areas that can collectively make up a flexible plan with structural and organizational patterns and spaces can adapt for patient volumes surges. Sustainable and efficient practices must be incorporated throughout the building. Design features reduce the total footprint through incorporating compact but universally adaptable room sizes to capitalize on the return on investment. The program elements should also be implemented with design features such as provisions for natural ventilation for increased air quality and minimal energy usage.

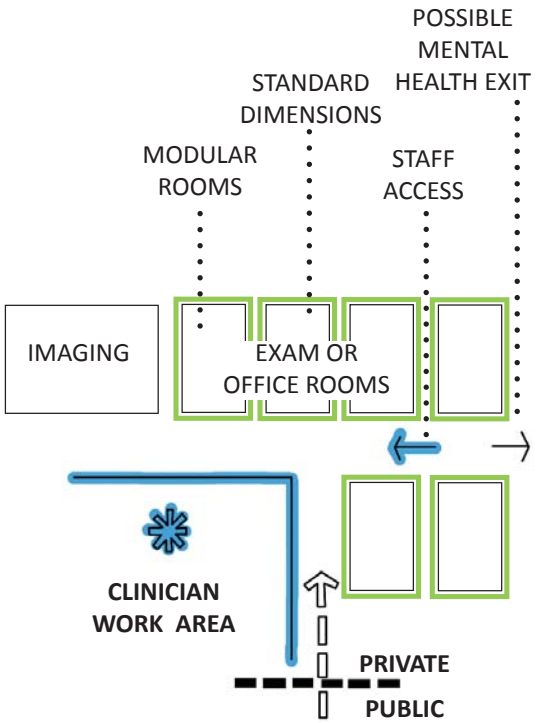


Figure 109: Diagram of Primary Care Area (Staloch). Guideline strategies can be implemented in the primary care area such as a central clinician work area, a separation barrier from the public space and open ended corridors to accommodate future expansion.

Typical models for community-fit clinics provide primary care and treat serious injury or illnesses until patients are stable and able to travel by road or air to an appropriate referral hospital or trauma center at a tertiary care institution. Additionally, staffing patterns impact the size of the building and the services offered. Based on precedent information from best practice case studies, the program must incorporate three connecting clinical units; a central staff work area, primary care and emergency care units. All care areas are programmed to support quality healthcare environments for optimal patient outcomes.

Along with the healthcare areas, the proposed model program anticipates ancillary and public use spaces that would vary depending on the needs of the community. The development of the overall program divides the program into health treatment areas, clinical work areas and public spaces. Beyond medical services, the model program includes space recommendations for clinician housing.

Healthcare treatment space: Inside the main healthcare areas, individual units separate primary care and emergency care. The vast difference in conditions and care necessitate different spaces for each unit. Space for imaging also becomes a separate unit within the treatment zone. The case study space information is summarized at the table on the following page.

Primary care operates with scheduled patients and providers to service healthcare needs for the area. In rural clinics this unit should have clinical exam rooms with telehealth and mental health appointment accommodations. Best practices for patient care develop private, user friendly and coordinated spaces

	Pictou Landing Medical Centre	CAH Prototype	Reeves County CAH	Ely-Bloomenson CAH	Legacy ER Freestanding ED	Delta Health Center FQHC	Peace Island Medical Center	Fort Providence Prototype	CrossRoads Medical Center FESC	**Recommendations**
Exam room	8’ x 12’	10’ x 10’	10’ x 10’		10’ x 12’	10’ x 12’	10’ x 12’	17’ x 12’	10’ x 12’	**10’ x 12’**
Clinician Work Area	120 SF	320 SF	210 SF	1400 SF	168 SF	120 SF	120 SF	420 SF + MED RM	168 SF	**200 SF***
Trauma Room	NONE	10’ x 20’	10’ x 19’	15’ x 17’	18’ x 12’	NONE	10’ x 15’	13’ x 18’	10’ x 22’	**12’ x 18’**
Treatment Room	NONE	10’ x 10’ (1 is ISO)	10’ x 10’ (1 is ISO)	10’ x 16’	8’ x 12’	NONE	10’ x 12’ (1 is ISO)	10’ x 12’	8’ x 12’	**12’ x 15’**
ED Work Area	NONE	350 SF	350 SF	SHARED	100 SF	NONE	350 SF	SHARED	100 SF	**SHARED**
Mental Health	8’ x 12’ + DOOR	-	ISOLATION RM in ED	-	NONE	NONE	ISO RM in ED	SHARED WITH OFFICE	NONE	**10’ x 12’ OFFICES AS NECESSARY**

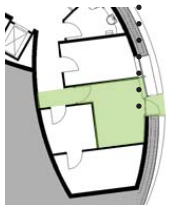


Figure 110: Pictou Landing Mental Health Plan with Exit Only Door (Source, Richard Kroeker Design, Diagrammed by Staloch)

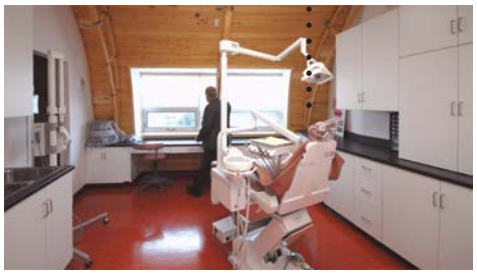


Figure 111: Pictou Landing Clinical Space (Source, Richard Kroeker Design)

Shared emergency and inpatient nurse work area

Nurse work areas vary in size and number depending on operations

Figure 112: Nurse work area at Ely-Bloomenson CAH (Source, Staloch)

One space combines urgent care exam, work space and temporary waiting

Figure 113: Isolation Room with Adaptable Rolling Door in the Emergency Department (Source, Staloch)

Figure 115: Exam room may Double as Practitioner Office (Source, Staloch)

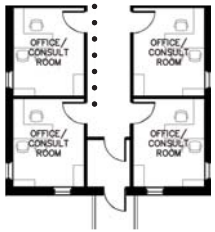


Figure 114: Mental Health Exit Only Door (Source: Stantec)

* Determine the size of the central staff work area based the number of providers (see matrix)

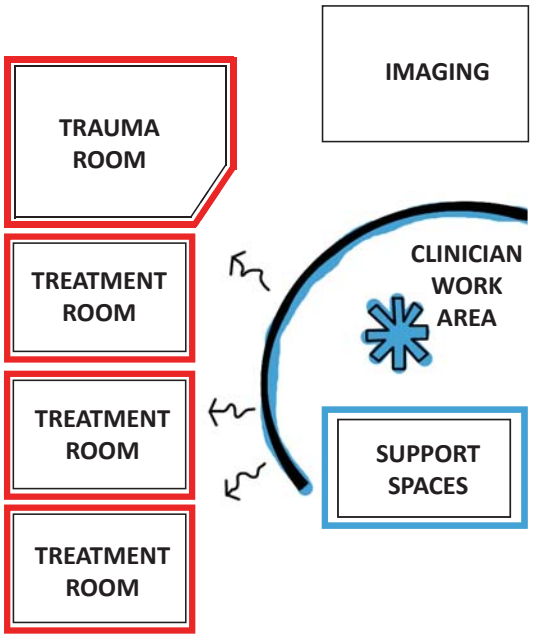


Figure 116: Diagram of Emergency Area (Staloch). Guideline strategies can be implemented in the emergency units such as a central clinician area that is visually connection to patients and universal treatment room layouts

for all patient care. Case study evidence for primary care exam room dimensions average 10’ x 12’.

Typical program conditions include four exam rooms in primary care. This is based off the case study examples and the research for health clinics in frontier areas. The number of providers affects the number of primary care spaces. See figure 118 to review a matrix for a provider: space ratio. Each of the rooms should be a standard dimension of 10’ x 12’.

If mental health needs exist and the appropriate providers work in the area, the program should include mental health offices that are modules with the primary care dimensions. Specialty areas of clinical practice at a rural health facility are usually supported by a regional partner health system. Rotating specialists may include mental health, dental, podiatry, ear-nose-throat otolaryngology, or gastroenterology. Some of these services may also be provided remotely via telehealth. Researched case studies included rooms to accommodate multiple specialties or provided ample telehealth features in standard exam rooms.

The emergency unit is utilized as it is needed in rural areas. There may not be many times when the unit is full or even serving one patient. Infrequent patient volumes impact the number of trauma and treatment rooms. Treatment rooms serve as multiple function rooms determined by the need of care in rural health facilities and may contain private toilet rooms. They could be used for urgent care, observation, holding or isolation. The recommended size determined from the case studies is 12’ x 15’. Frontier case studies usually included only one trauma room to accommodate the emergency needs.

	Room/Space		Unit	NSF	Total NSF
Medical treatment					
Primary	Exam room	10' x 12'	4	120	480
Emergency	Trauma room	12' x 18'	1	216	216
	Treatment room	12' x 15'	3	180	540
	Isolation Treatment room	12' x 15'	1	180	180
	Patient toilet room	8' x 8'	2	64	128
Imaging	Screening room	12' x 12'	1	144	144
	Mobile equipment alcove		1	40	40

Figure 117: Medical Treatment Space Program Table (Staloch)

Number of Practitioners*	Number of Physicians	Number of Exam rooms	Square Feet in work area
1	0	2	120
2	1	4	200
3	2	6	250
4	3	8	300

Figure 118: Matrix of the Number of Providers and the Recommended Space (Staloch)

* Practitioners would include registered nurses and advance care practitioners

The typical trauma room is slightly larger than standard treatment rooms.

For the model program, it is recommended that only one treatment rooms will be a mental health isolation room. This room should be designed to mental health standards and eliminate potential elements for self-inflicted harm. The recommended room is based off the Peace Island Medical Center isolation room and isolation spaces from other CAHs that altered one emergency treatment room to be converted into a mental health containment space. The isolation room at Peace Island Medical Center is located near the clinician work zone and includes a rolling door to close off part of the room. This separation allows complete isolation from the casework system while maintaining visual connection to the staff area.

Figure 119: Cook Hospital Trauma Room (Designed by DSGW Architects, Source: Staloch)

The treatment room that would be most likely used for patient observation and stability should include a patient lift. This quality care feature minimizes the possibility for staff injury and allows accessibility to the patient.

An imaging room should be adjacent to the emergency unit and available to primary care patients. One 12’ x12’ multiple purpose screening room will provide imaging services for the rural facility. Additionally adjacent to the room, storage space should be accounted for to hold portable imaging equipment. The Fort Providence prototype clinic uses a multi-screening room for x-ray screening and small out-patient procedures. Rural clinics should also accommodate mobile imaging equipment trailers to connect to the building. Mobile units arrive by truck in a designated parking area and connect directly to the building to service imaging needs for local patients.

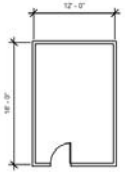
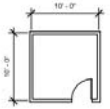
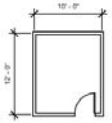
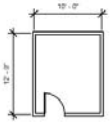
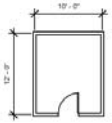
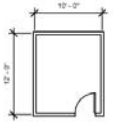
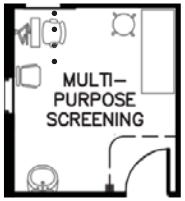
	Pictou Landing Medical Centre	CAH Prototype	Reeves County CAH	Ely-Bloomenson CAH	Legacy ER Freestanding ED	Delta Health Center FQHC	Peace Island Medical Center	Fort Providence Prototype	CrossRoads Medical Center FESC	**Recommendations**
										
Provider office	12’ x 18’	8’ x 8’	10’ x 10’	8’ x 8’	10’ x 12’	10’ x 12’	10’ x 12’	SAME AS EXAM	8’ x 10’	**10’ x 12’**
Laboratory	NONE	750 SF	880 SF	960 SF	NONE	400 SF	880 SF	80 SF	144 SF	**150 SF**
Pharmacy	NONE	275 SF	OUT	OUT	NONE	400 SF	300 SF	NONE	120 SF	**200 SF**
CT Scan	NONE	1,500 SF	250 SF	-	15’ x 18’	NONE	-	MULTI-PURPOSE SCREENING RM	NONE	**12’ x 12’**
Xray	NONE	1,100 SF	240 SF	-	10’ x 18’	NONE	-		12’ x 15’	**12’ x 15’**
Ultra sound	NONE	800 SF	350 SF	120 SF	NONE	NONE	-		PORTABLE	**PORTABLE**
Mammography	NONE	800 SF	250 SF	-	NONE	NONE	-	NONE	NONE	**MOBILE UNIT**
Body holding	NONE	NONE	NONE	NONE	NONE	NONE	64 SF	60 SF	OUT	**64 SF**

Figure 120: Body Holding Room at Fort Providence (Source, Staloch)



Adapt one space for many screening and procedure uses and operate imaging with portable devices

Figure 121: Multi-screening Room Plan at Fort Providence Medical Centre (Source, Stantec)

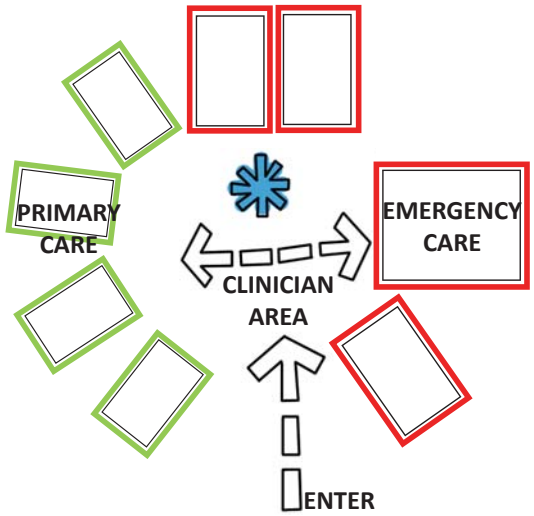


Figure 122: Diagram of Connection within Clinician Work Area (Staloch). Apply the guideline strategy to centralize a clinician work area. This minimizes redundant support space and allows staff to monitor who is entering and leaving the building.

Clinical work area: Rural clinics should accommodate clinical work areas to be effective for healthcare delivery, be efficient work spaces and promote staff satisfaction. With the extended length of time that clinicians spend in rural clinics, their work space must encourage healthy work environments and increase the quality of satisfaction to retain staff. To compensate for chronic staff shortages, their work zones must connect to registration, primary care and emergency care areas. Clinicians in rural areas may have to serve patients in the emergency care area while handling routine patients in another unit.

The staff work area should be designed to serve as a main hub with visual connections to all zones and flexibility for circulation. The design features should plan for times when limited staff may be the only people in the facility and their essential needs for security. The model program recommends a centralized station that accommodates the number of clinicians working in the space. Assessing from the case studies, the work area should be around 200 square feet.

To optimize staff work environments, confirm that natural views are available to the staff areas within the medical clinic. Views to nature optimize healing and rural medical facilities have more advantage to incorporate natural views compared to their urban counterparts.

The small building footprint and patient volume eliminates the need for redundant support spaces. Spaces for staff support include medication, clean, soiled, storage, toilets, and additional rooms as necessary. Figure 123 breaks down the recommended square footage of each of these areas.

	Room/Space		Unit	NSF	Total NSF
Clinician work area					
	Provider office	10' x 12'	2	120	240
	Central work area		1	200	200
	Laboratory		1	150	150
	Pharmacy		1	200	200
	Medication space		1	50	50
	Staff toilet room	8' x 6'	1	40	40
	Clean utility room	10' x 12'	1	120	120
	Soiled utility room	10' x 12'	1	100	100
	Body holding		1	64	64
	Break room		1	200	200
	Storage room		1	60	60

Figure 123: Clinician Work Area Space Program Table (Staloch)

In addition to the medical support areas, staff lounge areas are needed for respite. While staff members need to have a space to get away, some spaces may be shared with visitors and all others. CrossRoads Medical Center has a community kitchen that is centrally located for staff and visitors and a separate waiting space for visitors is provided within the public zone.

Clinician offices should be near the clinical zone of the facility. The number of offices depends on the number of clinicians that are employed full-time. Offices may also be designed as “hot” work spaces where more than one person may work out of the space at different times. A minimum of two offices is recommended and can be accommodated within the layout of the 10’ x 12’ standard room size.

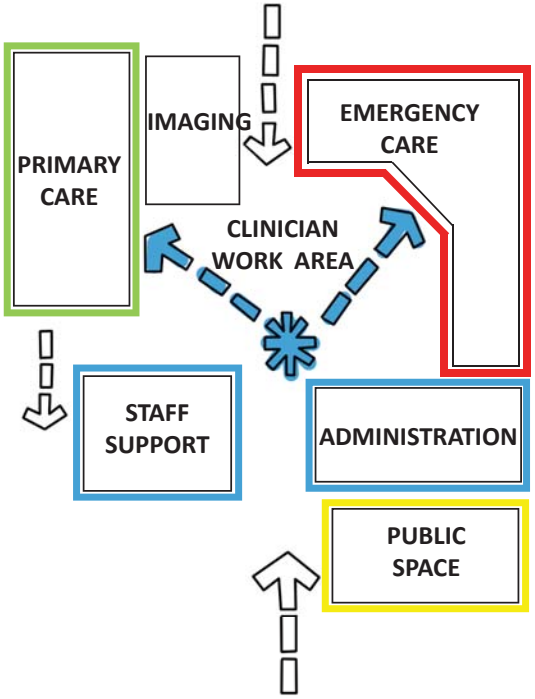


Figure 124: Diagram of Clinician Connection (Staloch). Circulation patterns should create a node in clinician work areas.

Pharmacy and laboratory spaces should be programmed near the staff space and the primary care unit to serve the intended community's medical needs. In many rural areas, commercial pharmacies are limited and most communities are even less likely to have laboratories services that adequately serve the needs for the community. The pharmacy should be sized to serve the needs of public users and any medication needs of the clinic. The recommended size based on the research is 200 square feet. Design a laboratory that can accommodate the services, lab equipment and testing needed most for frontier clinics should be around 150 square feet.

For frontier areas with minimal services, the medical facility often remains responsible for after-death body holding. The model program provides body holding space until funeral or transportation arrangements can be made. Many of the rural case studies incorporated this space in a private and separated area of approximately 64 square feet. In cases of patient death, cultural relevance includes accommodating any ceremonies associated with death and grieving. The proposed model program includes space for body holding and space for gathering that can flow into the large community room.

	Pictou Landing Medical Centre	CAH Prototype	Reeves County CAH	Ely-Bloomenson CAH	Legacy ER Freestanding ED	Delta Health Center FQHC	Peace Island Medical Center	Fort Providence Prototype	CrossRoads Medical Center FESC	**Recommendations**
Community Health	12' x 10' + RM	REHAB 400 SF	-	-	250 SF	NONE	300 SF + GATHERING SPACE	350 SF	OUT SOURCE CONFERENCE ROOM	**300 SF**
Waiting area	420 SF	320 SF	250 SF	320 SF	375 SF	200 SF	1500 SF	240 SF	400 SF	**240 SF**
Registration	70 SF	275 SF	200 SF	80 SF	144 SF	100 SF	880 SF	120 SF	250 SF	**120 SF**

Figure 125: Community Meeting Room at Pictou Landing (Source, Richard Kroeker Design)

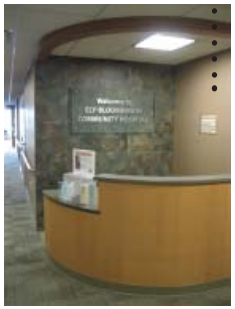


Figure 126: Registration Desk (Source, Staloch)

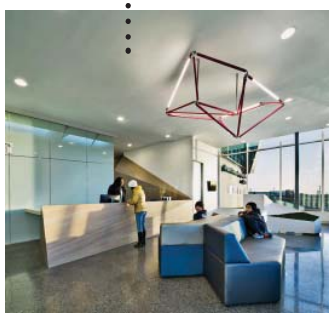


Figure 127: Registration and Waiting at Legacy ER (Source, 5G Studio)

Figure 128: Public Areas at Peace Island Medical Center (Source, Staloch)

Figure 129: Waiting Room at CrossRoads Medical Center (Source, Staloch)

Figure 130: Waiting Room at Peace Island Medical Center (Source: Mahlum Architects)

Public Spaces: The public zone of the clinic should accommodate all necessary spaces for the healthcare admission process including registration, waiting and circulation zones. This area of the building should remain separate and include adjacencies to the entrance, a large meeting space and the pharmacy. The entrance should welcome visitors and suit the correct climate. Cold and wet climates should have appropriate vestibules and storage for visitor winter wear.

The clinic waiting and registration spaces should be provided for the anticipated number of peak daily visits, patient throughput processes and efficiency operations. Recommendations from the research suggest planning 240 square feet for registration and 120 square feet for waiting space.

One large public space within the building should be designed to work for multiple large social functions and community activities. Rural healthcare facilities may be the only civic buildings in their communities and therefore they should service functions beyond clinical health needs. Gathering spaces in public zones should support a range of community social events and accommodate cultural ceremonies. The model program includes a community gathering room that accommodates large group activities for board committees or all staff meetings that could total forty to fifty people. The room could be used for group health examinations, education and social functions.

Gathering spaces and public zones in the project should express local culture and traditions. Pictou Landing designed a community room beginning with a regionally designed structure and incorporated art and materials to bring more culture to the space. This public meeting space serves multiple functions

for community members.

Additional rooms to accommodate cultural traditions may be necessary in some rural healthcare facilities. Sacred services or ceremonies may be appropriate to accommodate for culturally specific conditions that could impact the program of the project.

Depending on the medical system and process, space for administration offices could be modular space within the rural clinic. The model program includes offices for administrative staff with a size based on a standard modular dimension of 10’x 12’ so that these spaces could be repurposed if necessary. The number of offices depends on the staff processes and operations of the medical facility.

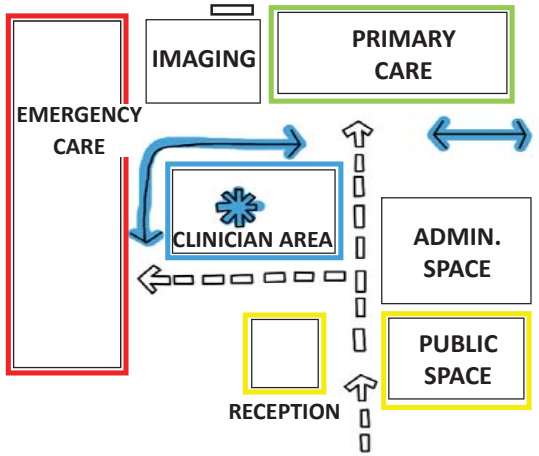


Figure 132: Overall Diagram of Circulation Paths (Staloch). Architectural objectives can be reached in overall design features such as a central clinician work area, small building footprint, connection for mobile imaging unit and share support spaces.

	Room/Space	Dimensions	Unit	NSF	Total NSF
Public Spaces					
	Main entrance vestibule		1	60	60
	Group meeting room		1	240	240
	Waiting Area	16 People	1	120	120
	Administration	10' x 12'	4	120	480
	Public Restroom		1	64	64
	Registration		1	120	120
	Storage room		1	120	120

Figure 131: Public Space Program Table (Source, Staloch)

	Pictou Landing Medical Centre	CAH Prototype	Reeves County CAH	Ely-Bloomenson CAH	Legacy ER Freestanding ED	Delta Health Center FQHC	Peace Island Medical Center	Fort Providence Prototype	CrossRoads Medical Center FESC	**Recommendations**
Bedroom	NONE	NONE	OUT	Bedroom			OFF SITE PROVIDER HOUSING	120 SF	OFF SITE PROVIDER HOUSING	120 SF
Kitchen	150 SF	1,250 SF	SHARED	Kitchen	NONE	NONE		80 SF		80 SF
Lounge	NONE	192 SF	200 SF	Living area				120 SF		120 SF

Food service for staff may share for patients and visitors

Figure 133: Provider Housing in Friday Harbor (Source, Staloch)

Figure 134: Provider Housing in Fort Providence, NWT, CA (Source, Staloch)

Figure 135: Provider Housing in Glennallen, AK (Source, Staloch)

Clinician housing: Clinician housing is often necessary to accommodate traveling providers and the provision of clinician living areas must be discussed in all rural projects. Medical provider housing is critical for the adequate delivery of healthcare in rural areas and should be incorporated into all medical centers that work with rotational providers. Living units based on staffing needs allow for staff to come and work for a period of time. Each unit should contain an open living area, kitchen, a private bedroom and bathroom. The square footage recommendation of these spaces is based on the Fort Providence Prototype model housing which includes a bedroom at 120 square feet, bathroom at 80 square feet, kitchen at 100 square feet and an open lounge space of 120 square feet.

	Room/Space	Unit	NSF	Total NSF
Provider housing				
	Provider bedroom	4	120	480
	Closet	4	20	80
	Toilet room with shower	4	60	240
	Kitchenette	4	80	320
	Living/dining area	4	120	480
	Laundry room	1	80	80
	Total			1680

Figure 136: Provider Housing Space Program Table (Staloch)

Figure 137: Peace Island Medical Center Public Gathering Hallway (Designed by Mahlum Architects, Source: Staloch)

Cultural impact on the spaces: The whole building should include cultural relevancy within the spaces. The planning should incorporate unique traditional elements throughout the building. The majority of the patients that require primary medical care and seek healthcare services will be community members and the facilities should come across as representing and reflecting the local context it serves.

Peace Island Medical Center started its foundation on the principle of serving the people in the San Juan Islands and creating an atmosphere of art and expression throughout the facility. Sculptured art of local wildlife and natural scenes can be found within patient waiting areas and clinical spaces. The site of Peace Island Medical Center is a wooded area and the removed trees from construction were sent to the local sawmill. Then the wood was incorporated back into the design of the iconic staircase and the clinical registration desks. A public circulating hallway expresses the history of healthcare on the island and functions as a public space for galleries and receptions. The architecture and design palette reference the island materials and colors.

Pictou Landing Health Centre planned a medicinal garden that coordinates with the sustainable environment and traditions of the Mi'Kmaq community. The site includes cultural gardens that incorporate the greater community traditions and provide a public access to use the site beyond healthcare.

The complete model program recommendations include separate public spaces, medical treatment spaces and clinician work areas. Each number of rooms and room dimensions resulted from research.

	Room/Space	Dimensions	Unit	NSF	Total NSF
Public Spaces					
	Main entrance vestibule		1	60	60
	Group meeting room		1	240	240
	Waiting Area	16 People	1	120	120
	Administration	10' x 12'	4	120	480
	Public Restroom		1	64	64
	Registration		1	120	120
	Storage room		1	120	120
Medical treatment					
Primary	Exam room	10' x 12'	4	120	480
Emergency	Trauma room	12' x 18'	1	216	216
	Treatment room	12' x 15'	3	180	540
	Isolation Treatment room	12' x 15'	1	180	180
	Patient toilet room	8' x 8'	2	64	128
Imaging	Screening room	12' x 12'	1	144	144
	Mobile equipment alcove		1	40	40
Clinician work area					
	Provider office	10' x 12'	2	120	240
	Central work area		1	200	200
	Laboratory		1	150	150
	Pharmacy		1	200	200
	Medication space		1	50	50
	Staff toilet room	8' x 6'	1	40	40
	Clean utility room	10' x 12'	1	120	120
	Soiled utility room	10' x 12'	1	100	100
	Body holding		1	64	64
	Break room		1	200	200
	Storage room		1	60	60
Building support					
	Laundry room		1	120	120
	General storage		1	500	500
	Computer equipment room		1	100	100
	Housekeeping room		1	60	60
	Mechanical room		1	650	650
	Service entrance		1	60	60
	Total				5,846
	Grossing factor	1.3			7600

Figure 138: Overall Space Program Table (Staloch)

However, the exact number of spaces should be determined based on projected utilization, staffing levels and the specific needs of each community. Circulation patterns between the staff and medical areas should be private. A main node in the building should divide this private space with the public paths and meeting areas.

In addition to the clinical areas, the building should also include appropriate mechanical and equipment spaces. Building support areas include a laundry room, housekeeping spaces and a service entrance.

Case study building programs included a net to gross factor that ranged from 1.25 to 1.4, the model program includes a grossing factor of 1.3. Total building square footage amounts to 7,600 square feet for the medical treatment spaces, clinician work area, public spaces and building support.

Figure 139: Alaska Frontier River (Staloch)

CONCLUSION

The intent of this thesis is to provide guidance on how architecture can support the access to and the delivery of healthcare in frontier communities. It is based on the understanding that many rural and remote communities lack access to primary and emergency care due to distance and provider shortage barriers. The needs of rural communities were used to identify a series of design objectives that architecture must accommodate to allow access for patients in isolated areas. The proposed unifying objectives for design claim that architecture must be accessible, promote high quality care, be viably sustainable, and maintain cultural relevance.

Health service conditions in frontier regions struggle with retaining clinical staff and optimizing the efficient and effective use of their services. Solving provider shortages in underserved medical areas is the first challenge for rural health. The design of a rural clinic can include staff centered environments that support efficient practices and optimize staff satisfaction. Solutions for rural clinic facility design necessitates a balance between staff focused design, best practices, and providing healthy patient centered-environments.

Guidelines distilled from the research outline how architecture can support access and provide appropriate settings for small rural clinics. Various guidelines should be taken into account when formulating a comprehensive building. The most common users of the building are the staff and the guidelines need to express their healthcare work processes. The guidelines also target operational processes with standardized plans.

Following the development of the design guidelines, a model space program provides options to determine space needs for a frontier clinic. Each of the public, staff and clinical zones are organized to support optimal uses for efficiency and effectivity. They collaborate to support patient care and community development.

Several limitations to the study of rural healthcare begin with the variations in culture across the extensive geography of rural America. A single solution cannot adequately support vastly different frontier communities with contrasting health needs. Population health needs will drive planning and design decisions for each clinic service and operation. The relative lack of access to and documentation of best practice case study examples for frontier healthcare facilities was a significant limitation in this study.

Recommendations for future research within rural healthcare need to focus on creative operational models for frontier clinics to employ. Processes change the viability of medical systems which impact how architecture can support the delivery of care. Understanding the whole process and using a proven best practice working operational model to start designing would be the optimal course. Another recommendation specifically involves developing a better understanding of emergency care spaces with minimal use and optimizing those spaces for greater flexibility and potential.

In conclusion, rural healthcare facilities can use design features to support access for the local community. Architectural research needs to continue to be developed for rural areas.

Figure 140: Alaska Frontier Mountains (Staloch)

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FIGURES CITED

1. RURAL: Photo by Ashley Martel

2. RURAL truck: Photo by Ashley Martel

3. RURAL landscape: Photo by Ashley Martel

4. Population Percentage of Frontier People: NCFC, 2012

5. Map of Frontier Counties in the United States: NCFC, 2012

6. RURAL ROAD: Photo by Ashley Martel

7. Health Information for Adolescents: NCFC, 2012

8. Adolescent Obesity: http://www3.pictures.zimbio.com/gi/Special+School+Helps+Teen+Combat+Childhood+LsQaWaiGOLel.jpg

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21. Alaska Frontier: Staloch

22. Literature Map: Staloch

23. Objectives: Staloch

24. Highway System in Alaska: Staloch

25. Glennallen Clinic on the Highway System: Staloch

26. Legacy ER Facade: 5G Studio. http://www.5gstudio.com/index.php/legacy-er-a

27. Community Clinic: http://www.thecitywire.com/sites/default/fi les/node_fi les/08-13/%5Bcurrent-user%3Afi eldname%5D/dscf1814.jpg

28. Nurses Required: https://d3n8a8pro7vhmx.cloudfront.net/sj/pages/497/attachments/original/1401948408/nurses_required.jpg?1401948408

29. Workforce with Telehealth: http://www.highgroundnews.com/galleries/Features/2014/baptist-tabletphoto-aa.jpg

30. Mobile MRI: http://www.monett-times.com/photos/17/48/77/1748772-L.jpg

31. Health Insurance: http://d2vhierclfllnw.cloudfront.net/wp-content/uploads/sites/7/2014/10/health-insurance.jpg

32. Waiting Room: http://www.westernfreepress.com/wp-content/uploads/2013/05/Crowded-Emergency-Room-Waiting_medicine_obamacare.jpg

33. Patient Communication: http://www.healthcaredesignmagazine.com/article/MGH#Page

34. Team Collaboration Space: http://www.aiohome.com/wp-content/uploads/2014/07/office-workspace-modern-apartment-furniture-ideas-with-small-space-design-and-unique-circle-tables-and-black-swivel-chairs-and-nice-pendant-lamps-design-office-interior-tips-amazing-office-space-design-ideas.jpg

35. Medicine Dispense Area: http://www.boots.com/wcsstore/cmsassets/Boots/Library/Icon/Content%20/B2B/CNV00032/CNV00032.JPG

36. Rural Trauma Room Setting: Staloch

37. Clinical Work Space Efficiency: Staloch. Designed by DSGW Architects

38. Locum Tenens Blog Advertisement: http://www.staffcare.com/positionsfor-locum-tenens-physicians-advancedpractitoners-washington-state/

39. Water Collection Tank: http://www.earthtimes.org/going-green/roofrainwater-runoff -collection-urged-experts/1542/

40. Protea Health Prototype: Farrow Partnership, Ngonyama Okpanum and Clark Nexsen

41. Cancer Mortality rates per 100,000: CARES, 2011

42. Heart Disease Mortality rates per 100,000: CARES, 2011

43. Most Common Health Conditions for People over 18: NHIS, 2012

44. Chronic Lower Respiratory Disease Mortality rates per 100,000: CARES, 2011

45. Unintentional Injury Mortality rates per 100,000: CARES, 2011

46. RURAL Abandon Building: Photo by Staloch

47. Isolated Communities: Photo by Staloch

48. Site Selection and Coordination Diagram: NCFC, 2014

49. Frontier Town Connection to Services: Google Map

50. CrossRoads Medical Center in a Frontier Town: Photo by Staloch

51. Pictou Landing Health Centre: Richard Kroeker Design http://richardkroekerdesign.com/

52. User Site Access for Small Community: Richard Kroeker Design http://richardkroekerdesign.com/

53. Public Space within Ed Roberts Campus: Leddy Maytun Stacy Architects http://www.archdaily.com/122507/ed-roberts-campus-leddy-maytum-stacy-architects/

54. Open Public Space: Leddy Maytun Stacy Architects http://www.archdaily.com/122507/ed-roberts-campus-leddy-maytum-stacy-architects/

55. Pictou Landing uses Sustainable Measures: Richard Kroeker http://richardkroekerdesign.com

56. Kiowa County Memorial Hospital received LEED Platinum: Steve Rasmussen Photography http://archpaper.com/uploads/11-healthcare-feature-disaster-preparation-architecture-archpaper.jpg

57. Section of Distilled Sunlight: Richard Kroeker Design, Diagramed by Staloch

58. Pictou Landing Distilled Sunlight: Richard Kroeker Design http://richardkroekerdesign.com/

59. Geothermal Diagram: Staloch

60. Patrick H. Dollard Health Center: David Allee http://archrecord.construction.com/resources/images/0408edit17.jpg

61. Roof view of solar panels at Martha's Vineyard CAH: Google Maps

62. Solar Panels at Martha's Vineyard CAH in Oak Bluffs, MA: TMPartners http://www.tmpartners.com/#!/portfolio/healthcare/marthas-vineyard-hospital

63. Kiowa County Memorial Hospital Wind Energy: Health Facilities Group Medical Planning & Architecture http://www.architectmagazine.com/practice/study-should-hospitals-seek-leed-certification_o

64. Wood Pellet Storage in Fort Providence, Canada: Photo by Staloch

65. Environmental Diagram of Peace Island Medical Center: Adapted Diagram from Guenter, 2013

66. Peace Island Medical Center Preserved Habitat: Photo by Staloch

67. Environmental Diagram of CAH Prototype: Adapted Diagram from BBH Design

68. CAH Prototype: U.S. CAH Prototype Project with BBH Design

69. Distilled Sunlight Diagram: Adapted from Studio 5G http://www.5gstudio.com/index.php/legacy-er-allen-i

70. Legacy ER Distilled Sunlight: Studio 5G http://www.5gstudio.com/index.php/legacy-er-allen-i

71. Modular Structure Pattern in the CAH Prototype: Adapted from U.S. CAH Prototype

72. Interior Structure of CAH Prototype: U.S. CAH Prototype and BBH Design

73. Structure Pattern of Peace Island Medical Center: Staloch

74. Exterior pattern at Peace Island Medical Center: Photo by Staloch

75. Modular Units and Future Expansion Plan: Adapted from Philip Patrick Sun presentation

76. Modular design for Delta Health in Mound Bayou, MS: Philip Patrick Sun presentation

77. Prefabricated Headwalls and Toilet Rooms: Adapted from NBBJ http://www.nbbj.com/work/miami-valley-hospital-heart-and-orthopedic-center/

78. Prefabricated units for Miami Valley Hospital: NBBJ http://www.nbbj.com/work/miami-valley-hospital-heart-and-orthopedic-center/

79. Standard Rooms at Ely-Bloomenson Hospital: Photo by Staloch

80. Standard Clinical Spaces at Delta Health: Philip Patrick Sun presentation

81. Standard Clinical Rooms at Delta Health: Philip Patrick Sun presentation

82. Standard Clinical Spaces at Fort Providence Medical Centre: Adapted from Stantec

83. Standard Clinical Rooms at Fort Providence Medical Centre: Photos by Staloch

84. Universal Room Layout at Delta Health: Adapted from Philip Patrick Sun presentation

85. Universal Room at Delta Health: Philip Patrick Sun presentation

86. Adaptable Room: Photo by Staloch

87. Public space to Accommodate multiple functions at Pictou Landing: Richard Kroeker Design http://richardkroekerdesign.com/

88. Multiple Purpose Screening Room at Fort Providence Medical Centre: Adapted from Stantec

89. Adaptable Rooms at Ely-Bloomenson CAH: Adapted from DSGW Architects

90. Adaptable Telehealth Room at Ely-Bloomenson CAH: Photo by Staloch

91. Organization of Rooms for a Clinical Purpose: Adapted from Mahlum Architects by Staloch

92. Organization of Rooms for a Offices: Adapted from Mahlum Architects by Staloch

93. Furniture System Used at Delta Health: HermanMiller http://www.hermanmiller.com/solutions/healthcare/products/healing-spaces/systems/compass-system.html

94. Connect Clinical Work Area with Entrance at Cook Hospital: Photo by Staloch

95. Central Work Area around Different Units: Adapted from 5G Studio

96. Central Work Area in Legacy ER: 5G Studio http://www.5gstudio.com/index.php/legacy-er-allen-i

97. Fort Providence Circulation Node during Construction: Photo by Staloch

98. Central Work Area around Different Patient Units: Adapted from DSGW Architects by Staloch

99. Clinical Circulation inside the Work Area at Ely-Bloomenson CAH: Photo by Staloch

100. Central Open Clinical Area: Adapted from HGA Architects

101. Open Clinical Area at Reeves County CAH: HGA Architects

102. Open Clinical Area: Adapted from BarberMcMurry Architects http://www.bma1915.com/index.html

103. Open Clinical Area at Hicks Orthodontic: BarberMcMurry Architects http://www.bma1915.com/index.html

104. Map of Provider Housing in Friday Harbor, WA to Peace Island Medical Center: Adapted from Google Maps

105. Peace Island Medical Center Provider Housing in Friday Harbor, WA: Photo by Staloch

106. Map of Provider Housing in Glennallen, AK to CrossRoads Medical Center: Adapted from Google Maps

107. Fort Providence Medical Centre Provider Housing in Fort Providence, Canada: Photo by Staloch

108. RURAL South Dakota: Photo by Ashley Martel

109. Diagram of Primary Care Area: Staloch

110. Pictou Landing Mental Health Plan with Exit Only Door: Adapted from Richard Kroeker Design http://richardkroekerdesign.com/

111. Pictou Landing Clinical Space: Richard Kroeker Design http://richardkroekerdesign.com/

112. Nurse work area at Ely-Bloomenson CAH: Photo by Staloch

113. Isolation room with Adaptable Rolling Door in the Emergency Department: Photo by Staloch

114. Mental Health Exit Only Door: Stantec

115. Exam room may Double as Practitioner Office: Photo by Staloch

116. Diagram of Emergency Area: Staloch

117. Medical Treatment Space Program Table: Staloch

118. Matrix of the Number of Providers and the Recommended Space: Staloch

119. Cook Hospital Trauma Room: Photo by Staloch

120. Body Holding Room at Fort Providence: Photo by Staloch

121. Multi-screening Room Plan at Fort Providence Medical Centre: Stantec

122. Diagram of Connection within Clinical Work Area: Staloch

123. Clinician Work Area Space program: Staloch

124. Diagram of Clinician Connection: Staloch

125. Community Meeting Room at Pictou Landing: Richard Kroeker http://Richardkroekerdesign.com/

126. Registration Desk: Photo by Staloch

127. Registration and Waiting at Legacy ER: 5G Studio http://www.5gstudio.com/index.php/legacy-er-allen-i

128. Public Areas at Peace Island Medical Center: Photo by Staloch

129. Waiting Room at CrossRoads Medical Center: Photo by Staloch

130. Waiting Room at Peace Island Medical Center: Mahlum Architects http://www.mahlum.com/projects/Peace Island/index.asp

131. Public Space Program Table: Staloch

132. Overall Diagram of Circulation Paths: Staloch

133. Provider Housing in Friday Harbor: Photo by Staloch

134. Provider Housing in Fort Providence, NWT, CA: Photo by Staloch

135. Provider Housing in Glennallen, AK: Photo by Staloch

136. Provider Housing Space Program Table: Staloch

137. Peace Island Medical Center Public Gathering Hallway: : Photo by Staloch

138. Overall Space Program Table: Staloch

139 Alaska Frontier River: Photo by Staloch

140. Alaska Frontier Mountains: Photo by Staloch